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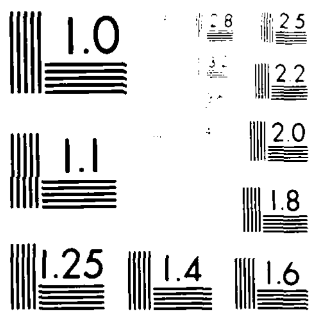
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Technical Report NAVTRAEQUIPCEN 78-C-0113-3

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TRAINING EFFECTIVENESS EVALUATION AND UTILIZATION DEMONSTRATION OF A LOW COST COCKPIT PROCEDURES TRAINER

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At the time the work described in this report was performed, Seville Training Systems Corporation was known as Seville Research Corporation. The corporate name change occurred during the time the report was being prepared for publication.

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Training devices
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this study was to evaluate a prototype low cost cockpit procedures trainer (LCCPT) for the SH-3H aircraft. During Phase I of the study, pilots trained in the LCCPT were compared in subsequent SH-3H performance with a historical control group trained in Device 2C44, a much more expensive conventional cockpit procedures trainer. The LCCPT and 2C44 groups performed equally well in the SH-3H. For tasks practiced in the LCCPT, transfer of device training to SH-3H performance was 95 percent as estimated

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through a curve fitting technique. During Phase II, the adaptability of the LCCPT to student-directed instruction (~~i.e., with reduced instructor participation~~) was evaluated. The students developed required levels of proficiency, and they appeared able to identify weaknesses in their performance and to direct their practice toward overcoming them.

PREFACE

In view of increasing fiscal limitations, Naval Air Systems Command (NAVAIRSYSCOM) requested and funded the experimental development and evaluation of a prototype low cost cockpit procedures trainer (LCCPT) for the SH-3H aircraft. Under Naval Training Equipment Center (NAVTRAEQUIPCEN) contracts and direction, an LCCPT was cooperatively designed by Seville Research Corporation (now Seville Training Systems Corporation) and Appli-Mation, Inc., with participation by Fleet Project Teams from Helicopter Squadron One (HS-1) and Helicopter Squadron Ten (HS-10), Naval Air Station Jacksonville and Naval Air Station North Island, respectively. The device was fabricated by Appli-Mation and finally experimentally evaluated by Seville Research Corporation under the contract with the NAVTRAEQUIPCEN. Captain P. Jasper and Messrs. J. Schreiber and R. Farris of NAVAIRSYSCOM provided valuable contributions, both technical and administrative, to various aspects of this project.

The LCCPT was designed to provide comparable instruction for the same normal and emergency cockpit procedures as is provided by a conventionally designed, much more expensive H-3 helicopter CPT (Device 2C44). Costs for developing the LCCPT were approximately 25 percent of the development costs for Device 2C44. This amounts to a savings of over one million dollars for the experimental low cost device in comparison with its conventionally designed counterpart. Hence the designation "low cost."

This report describes the acceptability and training effectiveness of the LCCPT under normal and modified conditions of use. Information was obtained for this purpose from two separate evaluations at two different operational sites (HS-1 and HS-10). Results from the first evaluation indicate that the LCCPT does what it was designed to do. The LCCPT permitted training to be conducted with the same content and to the same level of proficiency, and just as quickly, as the more expensive, conventionally designed counterpart device. The second evaluation demonstrated that, with proper utilization procedures, the role of the flight instructor when training with the device could be reduced.

The first evaluation consisted of a transfer of training experiment. Performances of trainees who were instructed on the low cost device were compared with performances of trainees taught on the conventional device. The comparisons were made both in the trainers and in the aircraft and included measures of time to criterion, trials to criterion, and the percent of proficiently performed trials. Further, trainees from the LCCPT were compared with their conventionally trained counterparts on individual procedures in the aircraft. These analyses were performed to determine whether one of the devices was more capable than the other for preparing trainees for particular tasks. The two devices are considered equal in their effectiveness for training cockpit procedures because no advantage could be attributed to either device based on these measures. Additional evidence for the efficacy of the LCCPT is provided by curve fitting techniques which indicate that approximately 95 percent of the skills acquired in the trainer transferred to the aircraft.

Due mainly to simulation discrepancies between the LCCPT and the aircraft, the operation of the trainer was not satisfactory to the instructors during the first evaluation. As a consequence, the instructors had to modify their normal instructional methods to achieve their training goals. To their credit, the instructors were able to adapt to the lower fidelity of the new device to achieve the high operational standards which are reflected in the evaluation results. The LCCPT was modified to incorporate significant instructors' suggestions concerning device fidelity for the second evaluation.

An important research question arising from the initial evaluation concerns the training qualities of devices of different designs when used in different ways. It is not unreasonable to expect, for example, that devices that are much lower in fidelity than the current low cost device can, through improved methods of use, be more effective than much higher fidelity and higher priced conventionally employed devices. Moreover, there is substantial evidence to indicate that certain deviations from high physical fidelity (e.g., elimination of irrelevant cues) produce superior learning even given the best conceivable use of high fidelity designs. The present research demonstrates, at least for the procedures monitored, that instructors can use lower fidelity devices to achieve training results that are equal to those of higher fidelity devices. Consistent with findings of prior research, it appears that the instructors employed mediation to emphasize to the trainees operational cues that were missing in the device, thus compensating for fidelity discrepancies. Definition of the most cost-effective combinations of fidelity designs and utilization procedures, however, is an important matter for further investigation.

The value attributed to the LCCPT in the foregoing is not meant to indicate that this research provided a definitive statement regarding the abilities of the two devices under a variety of operational conditions. Due to time, funding, and operational restrictions, a number of untoward experimental conditions limit the generality of the findings. Major limiting conditions include the following: Only six students were instructed on the LCCPT during this first experimental evaluation; data on Device 2C44 were historical rather than from a concurrently trained control group; Fleet selection of instructors was not truly random; and the reliability of the instructors' evaluations of trainees is unknown. If the net effect of unknown influences from these conditions favored performance on the LCCPT, the LCCPT could have looked better than it actually was. (Of course, the reverse is equally possible, in which case the LCCPT would not have looked as good as it really was.)

In opposition to this possibility, the trainees, evaluation procedures, and other relevant variables associated with LCCPT training were considered by the instructors to be representative of those associated with the generation of the comparison data from Device 2C44. The instructors, based on their extensive experience with the SH-3H aircraft, and in spite of their criticism of some of its simulation qualities, expressed confidence in the basic ability of the trainer. A more satisfying validation of this opinion, however, was a contribution of the second evaluation. The training conditions of the second evaluation would be sufficiently different from those of the first evaluation to test the "robustness" of the LCCPT, i. e., its ability to continue to train as well under a variety of operational conditions.

A traditional Cockpit Procedures Trainer (CPT) was not available for comparison with the LCCPT in the second evaluation. Therefore, a detailed comparison of performance of low cost versus conventional devices, as was done in the prior evaluation, was not repeated. The claim that the LCCPT provides high level training, however, was supported by the fact that, in the second evaluation, the LCCPT satisfied operational standards for trainee performance as a replacement for an Operational Flight Trainer in syllabus sections that called for cockpit procedures training. This finding extends the finding from the first evaluation--that the LCCPT provides training for cockpit procedures that is the equal of a conventionally designed system--to another situation and another system. The similarity of results across the two situations helps to establish that the conclusion derived from the first evaluation concerning the high training effectiveness of the LCCPT does indeed have general validity.

Additional confidence in the training capabilities of the LCCPT was derived from informal observations of training conducted in the device and discussions with students, Fleet Project Team members, and other instructors, all of whom supported the opinions noted from the first evaluation concerning the high quality of the LCCPT. This anecdotal information added valuable confirmation to the more formal quantitative data with regard to the training capabilities of the new device.

One of the more obvious differences between the training conditions of evaluations one and two, which helped demonstrate the robustness of the LCCPT, was imposed as a major experimental condition. The second evaluation was conducted to determine whether the training effectiveness of the LCCPT as observed in the first evaluation could be extended to a situation wherein peer and self-instructionare used to streamline the instructors' interactions with trainees. More fundamentally, the proposition being tested is that training can be made more efficient and even more effective through redefinition of the tasks performed by instructors and trainees. An important preliminary corroboration of this notion was obtained in the finding that some of the instructor time, which is relatively costly and much in demand, could be redirected to other activities with no apparent training detriment. A 34 percent reduction (10 hours for traditional approach versus 6.6 hours for low cost approach) in the time instructors normally spend with trainees was obtained. This reduction, however, was accompanied by a 266 percent increase (10 hours versus 26.6 hours) over previous syllabus schedules in the amount of time the device was used by trainees (student voluntary access to the device was unrestricted). The extent to which this trade-off between decreases in instructor time and increases in device usage time is necessary with the current or any other approach is not known. Further, the extent to which this trade-off may have undesirable effects (e.g., where device time is more scarce than instructor time) also is not known.

These issues require further investigation, along with questions regarding the most efficient roles for instructors and trainees and the feasibility of implementing these roles in operational settings. Another major area ripe for profitable investigation involves the design of the low cost device itself. For example, much lower cost designs are conceivable in our quest for cost effective training, and sufficient evidence is available to indicate that they can facilitate progress even more dramatically than the current designs.

Although the noted cost reductions apply mainly to the development of the device, life-cycle savings also are expected. This expectation is based on the consideration that the simpler design features and advanced utilization procedures of the LCCPT should reduce facility and support requirements. The feasibility of realizing overall life-cycle benefits from the LCCPT approach, however, has not yet been demonstrated. In spite of the preliminary nature of the products from this project, these results, supported by a similar NAVTRAEQUIPCEN research and development project related to the EA-3B aircraft, already have changed some long and strongly held positions and actions regarding training system design and use.

First, the low cost training systems developed under this and the related projects for the SH-3H and EA-3B aircrafts (Devices 2C62 and 2C63, respectively) have been adopted to provide "valuable and priority training . . ." in Fleet applications, in accordance with the experimental demonstrations. Second, the savings demonstrated in these two projects are being translated into similar savings for several production training systems; the costs of these production models represent revolutionary breakthroughs in training practice. Of even greater significance, however, is the role these projects can play in opening the door for exploration of the much greater potential that the field appears to offer.

To realize this potential, more support is needed. Funding shortages compromised aspects of the evaluations described in this report. Nevertheless, enough justification for low cost approaches to instruction has been provided by the current and other, similar investigations to encourage significant investments of research and development resources toward demonstrating and improving the technology and to recommend careful implementation of low cost approaches in operational training programs.

The success of this project is due to the extraordinary efforts of NAVAIRSYSCOM, the Fleet Project Teams, Seville Training Systems Corporation, and Appli-Mation, Inc., in coordination with the NAVTRAEQUIPCEN.

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SECTION I

INTRODUCTION

Aircrew training is an expensive and time consuming endeavor. At one time or another, virtually every known training method and medium has been used to develop operationally ready aircrews and to maintain their readiness. To meet these readiness training needs in the most cost-effective manner, the Navy has sought to increase its use of training devices and simulators where they can be demonstrated to be useful. Requirements to economize on aviation fuel have provided strong additional impetus for this increase, but other factors have contributed as well. The other factors include increasingly congested airspace, safety during training, the cost of operational equipment used for training, and a desire to capitalize on training opportunities that simulators provide for skills that cannot be trained effectively, safely, or economically in the air.

In spite of their relative economy, however, simulators can be costly to develop and use. Simulator costs approaching or exceeding the costs of the aircraft simulated are not uncommon. Even part-task devices in which only procedural elements of flying-related tasks can be practiced may represent unit costs in the millions of dollars, and the common practice of using flight instructors to instruct in such devices adds to the cost of training. Significant benefit would accrue to the Navy and to other flight training agencies if ways could be found to reduce the development and utilization costs of flight simulators and training devices.

In 1976, the Naval Training Equipment Center (NAVTRAEQUIPCEN) initiated a project to develop and evaluate lower cost flight training devices and lower cost approaches to training with such devices. The project, which was being conducted for the Naval Air Systems Command, involved the selection of a specific device training requirement for study, and for formulation of device design and utilization concepts, that would be low in cost compared to conventional design and utilization concepts. The effort included a development of a low cost device to meet the selected training requirement, evaluation of the training effectiveness of the device, and demonstration of the feasibility of reducing the cost of its utilization through a reduction in the role of the instructor during device training. The device was delivered to the Navy in September, 1979, and an evaluation was conducted of its training effectiveness in a training squadron during the period October, 1979 to February, 1980. A subsequent demonstration of its utilization in a training program that involved a reduced role for the flight instructor was conducted in another training squadron during the period February to May, 1981.

This report documents the conclusions reached during the training effectiveness evaluation and subsequent feasibility demonstration. The analysis of the training requirement and the initial formulation of low cost device design concepts have been documented previously.[1] The detailed device design is described in a report prepared by Appli-Mation, Inc., the developer of the device.[2]

BACKGROUND FOR THE EVALUATION

At about the same time the project to develop the lower cost flight training device was being planned, the Navy introduced Device 2C44, a Cockpit Procedures Trainer (CPT) for the SH-3H helicopter. Device 2C44 is generally representative of current-day CPTs, and the Navy's plans for its use were typical for comparable Navy devices elsewhere. Device 2C44 was installed at Jacksonville Naval Air Station (NAS) for use by Helicopter Squadron One (HS-1). HS-1 conducts fleet replacement pilot training for the SH-3H helicopter for the Atlantic fleet. Device 2C44 was developed for use in that training along with Device 2F64B, an Operational Flight Trainer (OFT) for the SH-3D (an earlier model of the SH-3H helicopter). Of course, the helicopter itself was also used.

Introduction of Device 2C44 was an early step in the enhancement of the training capabilities of HS-1. As part of that enhancement, it was also planned that Device 2F64B, whose design was generally considered to be obsolete, would be replaced with a newer OFT then under development. The newer OFT, Device 2F64C, simulates the SH-3H helicopter. (It was introduced at HS-1 in September, 1980.)

The existence of the new CPT, Device 2C44, at HS-1 and its use in fleet replacement pilot training provided a basis for contrasting a conventionally designed and relatively expensive state-of-the-art device with a specially designed lower cost device. Primarily for that reason, the SH-3H fleet replacement pilot training requirement at HS-1 was selected for the purpose of assessing the contrasting device design approaches. More specifically, it was decided that a low cost device would be developed that could provide the training being provided by Device 2C44, and that the relative training effectiveness of each device would be assessed.

An additional benefit of selection of the SH-3H fleet replacement pilot training requirement for the evaluation of the low cost CPT was the fact that a concurrent SH-3H training effectiveness study was being conducted by the Training Analysis and Evaluation Group (TAEG), located at the Naval Training Center in Orlando, Florida. The TAEG study involved the collection of data to determine the effectiveness of fleet replacement pilot training in a program

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[1] The initial efforts to formulate low cost device design concepts were conducted by the Human Resources Research Organization under NAVTRAEQUIPCEN Purchase Order No. N61339-77-M-0533. Those efforts were documented in a letter report submitted to the Naval Training Equipment Center, Code N-215, dated 31 January 1977.

[2] Hagerty, H. S. Specification for cockpit procedures trainer (Report No. AIOR/3278). Orlando, FL: Appli-Mation, Inc., August 1978.

conducted with Device 2C44 and the SH-3H helicopter.[1] Device 2F64B, the existing OFT, was not used during the TAEG study. The purpose of the study was to establish a training effectiveness "baseline" against which other training could be compared. For example, training conducted in a program using Device 2C44, the SH-3H helicopter, and Device 2F64C (when that OFT became available) could be compared with the baseline training program to determine the relative worth of the addition of training in the new OFT. Similarly, the baseline program could provide a ready comparison reference for evaluating the training effectiveness of the low cost device which is the subject of the present report. The TAEG baseline study was concluded in October 1979, as the present study was being initiated.

THE LOW COST DEVICE

A detailed description of the device evaluated during the present effort may be found in the previously cited design documents. The description that follows is intended only to communicate the general nature of the device and to identify its principal training features. Principal features which distinguish it from Device 2C44 are also identified.

The device was designed to provide training in the performance of cockpit procedural tasks required during the normal and emergency operation of the SH-3H helicopter. Hence, the device is a CPT. Because of the low cost design goals underlying its development, it was identified as a Low Cost Cockpit Procedures Trainer (LCCPT) and will be identified in that manner throughout the present report.

The LCCPT, as is the case with conventional CPTs such as Device 2C44, consists of a full-scale representation of the cockpit area or section of the simulated aircraft. All aircraft components significant to training forward of the bulkhead behind the pilot's and copilot's seats are represented in the device. Cues associated with performance of all cockpit tasks not involving flight per se are represented in the device, and controls appropriate for responding to those cues are also present. In addition, a control console is provided through which normal and abnormal or emergency aircraft conditions are introduced to present a variety of training situations.

There are four principal differences between the LCCPT and Device 2C44: (1) the LCCPT is a lower fidelity device with respect to some of its components and response characteristics[2]--that is, the physical similarity of the LCCPT to the SH-3H is less than is that of Device 2C44; (2) the LCCPT includes simulation of engine and other sounds associated with performance of cockpit procedural tasks, whereas Device 2C44 includes no sound simulation; (3) the LCCPT instructor's console is movable so that instruction may be conducted

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[1]Browning, R., McDaniel, W., & Scott, P. Preparation and design for a training effectiveness evaluation of Device 2F64C for replacement pilot training (Technical Report TR 108). Orlando, FL: Training Analysis and Evaluation Group, August 1981.

[2]Examples of lower fidelity design features are provided in Appendix A.

from behind the pilot-copilot positions or from the pilot or copilot seat, whereas instruction in Device 2C44 can only be conducted from behind the pilot-copilot positions (in Device 2C44, the location of the instructor's console is fixed to the rear of the copilot position); and (4) the design of the LCCPT permits a limited self-instructional capability including computer aided problem set-up and automatic scoring of student performance. The self-instructional capability of the device is described in Section III of this report.

PHASES OF THE PROJECT

The self-instructional features of the LCCPT were not fully developed at the time the device evaluation was scheduled to begin at HS-1. Rather than delay the evaluation, it was decided that the effort would be divided into two phases. The first phase would address the training effectiveness of the low cost device under normal conditions of use, while the second phase would address its use with limited dependence upon flight instructors to conduct the required training in the device. During the first phase, instruction in the device would be conducted by an instructor operating the control console in a manner which would correspond to that employed with Device 2C44, and the device's training effectiveness would be assessed. During the second phase, the involvement of the instructor in the instructional process would be reduced so that the utility of the self-instructional capability of the LCCPT could be demonstrated.

Following the conduct of the first phase at HS-1, the device underwent modification to increase its fidelity and durability, and its self-instruction capability underwent further development. Upon delivery of Device 2F64C during that time period, HS-1 training and R&D resources were directed toward the new OFT, allowing little opportunity for continuing evaluation of the LCCPT. Therefore, it was decided that the second phase of the evaluation should be conducted at Helicopter Squadron Ten (HS-10), the SH-3H Fleet Replacement Training Squadron for the Pacific fleet, located at NAS North Island, California.

SECTION II

THE TRAINING EFFECTIVENESS EVALUATION

APPROACH

The purpose of the LCCPT Phase I evaluation effort was to determine the training value of the device in SH-3H fleet replacement pilot training. The effort was conducted at HS-1, Jacksonville NAS, Florida. Primary interest of the Navy personnel involved centered upon a comparison of the effectiveness of the new device with that of the existing Device 2C44. This was a logical comparison, since both devices were designed to address the same training requirements. Thus, the evaluation involved use of the LCCPT as a substitute for Device 2C44 in the training of SH-3H fleet replacement pilots.

Two conditions imposed severe time constraints on the study. First, the LCCPT was not ready for evaluation until October 1979. (At this time, the TAEG study to determine a training effectiveness baseline was completed, and Category I SH-3H fleet replacement pilot trainees became available for the current effort.) Second, the new SH-3H OFT, Device 2F64C, was planned for introduction at HS-1 during April or May, 1980. Since HS-1 personnel felt that their resources would not support both the LCCPT evaluation and introduction of the new OFT, the planned evaluation would have to be terminated when the OFT arrived. Thus, a period of only about six months was anticipated during which the LCCPT could be used before the new device was to be introduced.[1]

EXPERIMENTAL DESIGN. The projected Category I trainee load for SH-3H fleet replacement pilot training at HS-1 during the period of the study was an average of approximately three per class, with six classes scheduled during the period of interest. Since some loss of trainees due to reassignment, disruption to their training schedule, or other factors had to be considered likely when conducting studies in operational training settings, it was expected that, at the most, fifteen trainees would constitute the subject population available for the evaluation. Because pilot performance during fleet replacement pilot training is known to be subject to large variability from individual to individual as well as from flight to flight, the number of trainees available to participate in the evaluation was smaller than was desired for a two-group comparison. Therefore, it was concluded that the evaluation could not conform to a control group design in which performance of a test group of subjects trained in the LCCPT could be compared with that of a control group trained concurrently in Device 2C44.

In view of these considerations, all trainees available during the period of the evaluation were assigned to the experimental group. The comparison or "control" group consisted of the sixteen students trained in Device 2C44 during the TAEG baseline study that was concluded immediately prior to the

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[1]Due to delays in the delivery of Device 2F64C that were not anticipated during the fall of 1979, the new OFT was not introduced in HS-1 training until September, 1980.

beginning of the training of the LCCPT group. Except for the difference in the devices used for their training, the LCCPT (experimental) group and the 2C44 (control) group were treated alike insofar as was practical within the HS-1 fleet replacement pilot training program. The evaluation followed the paradigm for the Pre-Existing Control Transfer Design.[1] Trainees were trained to perform cockpit procedures in the LCCPT, and their proficiency in the performance of those procedures was evaluated during subsequent trials in the SH-3H helicopter. Their performance both in the device and in the helicopter was compared with that of the pre-existing control, or TAEG baseline, group.

SUBJECTS. Experimental and control subjects consisted of all Category I SH-3H fleet replacement pilot trainees[2] assigned to HS-1 during the periods of training of the two groups and who completed that training in accordance with the published syllabus. Trainees whose training was interrupted for extended periods during which they engaged in other training activities or who received flight training in a sequence other than that specified in the syllabus were excluded. The first trainee to undergo training in the LCCPT was also excluded, although he met other criteria for inclusion in the study, because he received additional training in Device 2C44 prior to beginning flight training. The second LCCPT trainee received a second performance check in Device 2C44 following the final period of training in the LCCPT, but he was not excluded. These deviations in procedure for the first two LCCPT trainees were made by the flight instructors because of their initial concern over the adequacy of training in the LCCPT, since they perceived it to be of lower physical correspondence to the SH-3H than was Device 2C44. More will be said about the instructors' perceptions of the fidelity of the LCCPT in a later section of this report.

INSTRUCTORS. All instructors who participated in the evaluation were qualified SH-3H flight instructors and had received instruction in the use of Device 2C44. The six instructors who conducted training in the LCCPT received additional instruction in the operation of that device and in its effective use. All but one of these latter instructors had also participated in the earlier TAEG baseline study and had been briefed by TAEG personnel to assure their standardized treatment of all students. The one exception was briefed on the procedures followed in the TAEG study and on the performance standards employed in it, since the same procedures would also be followed in the LCCPT study.

DEVICE TRAINING. All training in the LCCPT and in Device 2C44 followed the HS-1 device training syllabus. Seven periods of instruction (AW-1 through AW-7X) of approximately two hours' duration each were scheduled for device training, although a lesser or greater number of periods could be scheduled

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[1]Caro, P. W., Shelnutt, J. B., & Spears, W. D. <u>Aircrew training devices: Utilization</u> (AFHRL-TR-80-35). Brooks AFB, TX: <u>Air Force Human Resources Laboratory</u>, January 1981.

[2]Category I students are recent graduates of Naval undergraduate helicopter pilot training and have had no prior experience piloting the SH-3H helicopter.

for a particular trainee, depending upon his individual progress. In addition, the trainees engaged in individual study involving workbook assignments and use of audio visual aids developed through an instructional systems development process. The information acquired during this study was supplemented as required by the flight instructor during periods of device and aircraft training.

The content of training in the device consisted of practice of 61 normal and emergency procedures identified in the SH-3H NATOPS Flight Manual and listed on the HS-1 Training Form. Training was administered by an instructor seated in the copilot seat (in the LCCPT) or behind the trainee pilot (in either device). Trainees executed the required procedures in the sequence identified on the Training Form for the respective training period. Guidance and feedback were provided as the trainees attempted a procedure, as were explanations and supporting descriptions of aircraft systems that might be needed by the trainees to supplement the knowledge they had acquired during prior study. This process continued until the instructor determined that the required skills had been acquired.

Instructor-trainee pairings at HS-1 were normally based on instructor availability and varied from one period of instruction to another. In the case of the LCCPT group, all training in the device was conducted by the six flight instructors trained in its use. Within that group of instructors, however, instructor-trainee assignments were not preplanned. All HS-1 flight instructors were available for conduct of training in Device 2C44 during the TAEG baseline study. Instructor-trainee assignments during that study also were not preplanned.

FLIGHT TRAINING. Only when each trainee concluded training in Device 2C44 or in the LCCPT did he begin A-Stage flight training in the SH-3H helicopter. The purpose of A-Stage flight training was to train helicopter-qualified pilots to fly the SH-3H helicopters (mission-related tasks are trained during a subsequent stage); therefore it included practice of all of the normal and some of the emergency procedures tasks appropriate to the aircraft and included in the earlier device training. (Certain emergency procedures tasks judged unsafe for practice in the aircraft were practiced in the procedures trainer only.) In addition, the A-Stage flight syllabus included maneuvers necessary to operation of the helicopter. Forty-nine maneuvers and procedures were involved. Proficiency on these maneuvers and procedures is requisite to satisfactory completion of A-Stage training. As in device training, training activities followed the sequence of tasks to be practiced as identified on the HS-1 Training Form appropriate to the flight.

A-Stage flight training consisted of six scheduled flights (AF-1 through AF-6X) of approximately 2 1/2 hours' duration each, although a greater number of flights might be required for any particular student, and the duration of flights varied. Usually, flight training began within one week of completion of training in the device. All training was conducted by qualified flight instructors following the HS-1 A-Stage flight syllabus. Instructor-trainee pairings in the aircraft also were based upon instructor availability and varied from flight to flight. All pilots assigned to HS-1 were considered to be available to participate in the flight training of both the LCCPT and the 2C44 students.

PERFORMANCE ASSESSMENT. Assessments of performance in the devices as well as in the aircraft were based on the judgment of the flight instructors. Criteria for these judgments, however, were defined by TAEG personnel for the baseline study, and the TAEG criteria and performance data recording procedures were adopted for the present evaluation. These criteria consisted of the proficiency standards specified in the SH-3H NATOPS Flight Manual for each maneuver and procedure. Thus, each time a maneuver or procedure was attempted, the instructor judged whether it had been performed to "NATOPS standards," i.e., as specified in the NATOPS Flight Manual for the SH-3H.

These judgments were recorded by the instructors on the appropriate HS-1 Training Form as a trial on which NATOPS standards had been demonstrated, or as a trial on which they had not. This procedure yielded a record of the number of trials attempted as well as an indication of the proficiency exhibited on each trial. The number of procedures on which NATOPS standards were indicated to have been met served as a measure of the relative proficiency of the trainee involved.

RESULTS

In early January, 1980, after two groups of trainees had undergone training in the LCCPT, use of the low cost device was terminated by HS-1. The termination resulted from the desire of the flight instructors who were conducting training in the device to conduct the required training instead in Device 2C44. At the time the effort was terminated, seven trainees had completed device training, although, as noted earlier, one of them had received additional instruction in Device 2C44.

By virtue of this unplanned termination, the LCCPT group consisted of only 6 trainees whose training was considered suitable for the purposes of this study, a number lower than had been planned. The 2C44 group with which comparisons were to be made consisted of 16 trainees. Except as noted, then, the results of the training effectiveness evaluation reported here are based on the performance of these 22 trainees.

The records of the two groups of trainees were reviewed to determine whether they could be considered similar with respect to qualification for SH-3H fleet replacement pilot training. Specifically, each trainee's overall flight grade from the Advanced Phase of undergraduate pilot training, completed just prior to assignment to HS-1, was examined.[1] It was found that the mean grade on this measure of pilot skill was the same for each group, i.e., 3.01. Therefore, for the purposes of the present study, the two groups were considered equivalent in their initial qualification for the training provided.

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[1]Trainee performance during Navy UPT is graded on a four-part scale. The points are: Above Average (4), Average (3), Below Average (2), and Unsatisfactory (1). An overall grade is derived by averaging the points accumulated during key graded flights.

The analyses of training data addressed two questions. First, how did the students trained with the LCCPT compare in A-Stage performance in the aircraft to students trained using the 2C44? Second, to what extent did the LCCPT training transfer to A-Stage performance in the aircraft? Because no control group that trained only in the aircraft was available for comparison, the second question required fitting of curves to performance data for LCCPT trainees. Although the curve fitting technique is not in common use for such analyses, the procedure and interpretation of results are straightforward and are described in a subsequent section of this report.

ORGANIZATION OF DATA. Two dependent measures of performance were analyzed. One, the time required to complete A-Stage training in the aircraft, applied only to comparisons of LCCPT and 2C44 groups. The second, which applied to both questions, was a measure of trial-by-trial proficiency both in the devices and in the aircraft. This latter measure was based on instructor evaluations of each trial according to whether the trainee's performance on a given task met standards for that task as specified in the SH-3H NATOPS Flight Manual. On this basis, percents of trainees who met proficiency standards on each trial, or percents of proficient trials for a single subject or group, were the data analyzed.

The numbers of evaluated trials per task varied across trainees and according to the task involved. There were also variations in the number of days of device and aircraft training on which performance on particular tasks was evaluated. Instructors used their judgment as to the need for a particular student to practice a task, taking into account that student's overall performance, condition of flight, and other factors. On occasions when performance had stabilized at or near 100 percent on particular tasks, i.e., proficiency standards were being met on virtually all trials, the instructor stopped recording their evaluations on those tasks. For example, evaluations on Basic Airwork in the aircraft were recorded an average of only 1.5 times each for the two groups, although there were six flights. Both groups showed proficiency in the performance of this task on their evaluations, the LCCPT group at 100 percent.

<u>Grouping of Tasks</u>. The principal concern for assessing the training value of the two devices being compared is the effects on subsequent aircraft performance of what is learned using each of them. Hence, tasks that were to be performed in the aircraft were divided into two sets, those that could be performed in the device and those that could not. The first set consisted of tasks involving primarily procedural skills. These tasks were the targets of device training. The second set consisted mostly of tasks related directly to aircraft control during flight maneuvers.

There are 49 separate maneuver and procedures tasks listed in the SH-1 and SH-3H fleet replacement pilot A-Stage flight syllabus. These are the tasks that were to be evaluated during A-Stage training in the aircraft. On four of the tasks, student performance was not evaluated: Ground Landing Signals; Normal Flight; Dual Engine No Hover Pad Landings; and Cut Gun in 10 ft. Hover. Of the remaining 45 tasks, two were general in nature and involved combinations of separately listed tasks: Basic Airwork and Cockpit Procedures. The 45 tasks that were evaluated were divided into the two sets described in the paragraph above: 20 (including Cockpit Procedures) in the set having aircraft-device counterparts and that consequently could be performed in both a device and the aircraft; and 25 (including Basic Airwork) in the set performed only in the aircraft.

COMPARISONS OF LCCPT AND 2C44 GROUPS. Three types of comparisons were made: (1) mean group proficiency on tasks common to the devices and aircraft; (2) mean group proficiency on tasks performed only in the aircraft; and (3) mean total aircraft training times. For the first two comparisons, the total number of proficient trials assigned a group for each task was divided by the total number of evaluated trials for the task, yielding a percent of proficient trials for each group on that task. Mean total aircraft training times were simply the averages of clock hours subjects logged in completing A-Stage training in the aircraft.

Tasks Common to the Devices and Aircraft. Table 1 shows mean percent proficient trials during A-Stage practice for the two groups on 20 tasks common to the devices and aircraft. Results shown include evaluations for the general procedural task, Cockpit Procedures. Overall performance was highly similar as indicated by weighted 19-task means, although the 2C44 group was significantly more proficient ($p = .05$) on two tasks, ASE Malfunction and Servo Malfunction. No other difference was statistically significant (see Appendix C for significance tests).

Because performance generally improved with practice, it is important to compare as well the mean number of evaluated aircraft trials for the two groups. That is, if one group had substantially more trials on a task, the mean could be enhanced because there would have been more later trials to counterbalance relatively poorer performance on early trials. The two columns on the right of Table 1 present mean trials evaluated per task. Again, the means are similar, with the LCCPT group having .48 (11 percent) more trials on the average. Also, it is apparent that the superiority of the 2C44 group on the two tasks just mentioned was not due to more practice, because in those cases the 2C44 group did not have more trials than the LCCPT group.

A further consideration is whether either group had an advantage due to greater amounts of achievement or practice in the devices prior to its training in the aircraft. Table 2 shows such not generally to be the case. One exception was ASE Malfunction, where the 2C44 group was superior in the aircraft and had 75 percent proficient device trials versus 50 percent for LCCPT subjects; they also had almost twice as much device practice--4.3 versus 2.3 trials. Two other exceptions were Before and After Landing Checklists on which the LCCPT group did better in the device, although with only a slightly greater number of trials. However, overall performance was highly similar, and overall differences in numbers of trials were negligible.

The tasks just discussed were essentially procedural in nature, and it is evident that the lower fidelity of the LCCPT led to no disadvantage with respect to performance of these tasks in the aircraft.

Tasks Practiced Only in the Aircraft. Table 3 presents comparisons of trainee performance on the 25 tasks that could not be practiced in the devices and consequently were evaluated only in the aircraft. Overall, the 2C44 group was slightly superior, but not significantly so for any of the 25 tasks nor for

TABLE 1. SUMMARY OF PERFORMANCE IN THE AIRCRAFT ON TASKS COMMON TO THE DEVICES AND AIRCRAFT

Task	Mean Percent Proficient Trials		Mean Number of Trials	
	LCCPT	2C44	LCCPT	2C44
Normal Start	92	93	4.3	3.8
Blade Spread	92	94	2.0	2.1
Systems Check	66	76	5.8	5.6
No. 2 Engine Start	92	86	6.2	5.8
Rotor Engagement	62	71	5.7	5.6
Taxi Checklist	97	95	5.5	5.1
Pre-Takeoff Checklist	100	94	5.7	5.1
Takeoff Checklist	97	95	5.7	5.1
Post-Takeoff Checklist	97	96	5.0	4.9
ASE Malfunction	58	74*	5.5	5.6
Servo Malfunction	50	68*	5.7	4.7
Manual Throttle	75	79	2.7	3.0
Before Landing Checklist	94	94	5.3	5.1
After Landing Checklist	100	97	5.2	4.9
Shutdown	94	96	5.5	4.9
Rotor Disengagement	91	87	5.5	4.8
Blade Fold	73	67	2.5	1.3
No. 1 Engine Secure	95	88	3.3	1.6
Postflight	100	97	4.8	3.8
19-Task Mean	85	87	4.8	4.4
Cockpit Procedures	100	97	3.2	2.4

*Significantly greater than corresponding mean (p = .05).

TABLE 2. SUMMARY OF DEVICE PERFORMANCE ON TASKS COMMON TO THE DEVICES AND AIRCRAFT

Task	Mean Percent Proficient Trials		Mean Number of Trials	
	LCCPT	2C44	LCCPT	2C44
Normal Start	74	76	9.5	9.8
Blade Spread	77	84	8.0	7.2
Systems Check	63	57	7.7	9.2
No. 2 Engine Start	76	83	9.8	8.9
Rotor Engagement	66	67	7.8	8.8
Taxi Checklist	97	86	6.5	6.4
Pre-Takeoff Checklist	92	92	6.5	6.0
Takeoff Checklist	95	85	6.7	6.4
Post-Takeoff Checklist	89	88	6.3	5.3
ASE Malfunction	50	75**	2.3	4.3
Servo Malfunction	87	76	2.5	2.8
Manual Throttle	71	62	2.3	2.1
Before Landing Checklist	95*	83	6.2	5.9
After Landing Checklist	97**	82	6.3	5.7
Shutdown	76	82	7.5	6.1
Rotor Disengagement	71	80	7.5	6.1
Blade Fold	63	70	6.8	5.7
No. 1 Engine Shutdown	86	84	7.0	6.0
Postflight	100	92	3.2	3.1
19-Task Mean	80	79	6.4	6.1

NOTE: No general evaluation of cockpit procedures was made in the LCCPT.
*$p < .05$.
**$p < .01$.

TABLE 3. SUMMARY OF PERFORMANCE ON TASKS PRACTICED ONLY IN THE AIRCRAFT

Task	Mean Percent Proficient Trials		Mean Number of Trials	
	LCCPT	2C44	LCCPT	2C44
Preflight	20	40	0.8	0.9
Course Rules	96	94	4.7	3.9
Taxi	97	90	4.8	5.2
Normal Takeoff	42	55	16.5	16.3
Running Takeoff	54	65	9.3	9.9
Beeper/Stick Trim & Bar Alt	100	62	1.0	0.8
ASE Off Flight	66	61	6.8	6.9
ASE Off Landing	57	62	10.0	9.4
ASE Off Takeoff	35	50	2.8	3.2
Aux/Pri Off Flight	61	74	5.5	5.4
Auto Rotation	25	38	16.5	16.0
S/E Failure	23	35	3.7	1.9
S/E Malf Anal	33	29	1.5	1.8
S/E Approach Runway	44	50	9.8	7.6
S/E Landing Runway	64	78	6.5	5.8
S/E Approach Pad	53	62	2.8	5.1
S/E Landing Pad	76	65	2.8	5.1
S/E Waveoff	70	67	3.8	4.9
S/E Malf Abort Takeoff	48	69	3.8	3.8
Normal Approach	33	41	16.0	16.2
Normal Landing	53	62	25.6	25.5
Run On Landing	55	48	11.0	12.0
Pad Work	100	100	0.7	0.4
Aux Off Landing	52	57	8.3	7.9
24-Task Mean	51	58	7.3	7.3
Basic Airwork	100	84	1.5	1.6

total performance. As shown in Appendix C, variances for percents were often large, so given the small numbers of subjects, significance was not obtained even for tasks with appreciable differences in proficiency.

Time Required for A-Stage Flight Training. On the average, the LCCPT group logged 15.6 aircraft hours during A-Stage training and the 2C44 group 16.7 hours. The difference does not approach statistical significance. Furthermore, the LCCPT group had fewer hours on the average in the device, with a mean of 14.3 hours versus 15.8 for the 2C44 group.

TRANSFER OF LCCPT TRAINING. Results presented in this section apply only to the LCCPT group. Data were not available in sufficient detail for similar analyses of transfer of 2C44 training.

Technique for Quantifying Transfer. Transfer of LCCPT training to subsequent aircraft performance can be easily assessed through curve fitting techniques. The logic is straightforward. A suitable descriptive curve is fitted to performance data (percent proficient trials) for LCCPT acquisition. If the skills acquired are transferred 100 percent to aircraft performance, then percent proficient trials in the aircraft would conform, trial by trial, to extrapolations of the LCCPT curve. If aircraft performance falls below the extrapolations, the percent transfer is reduced accordingly. If aircraft performance significantly exceeds extrapolated values, additional learning must have occurred in the aircraft.

The technique is illustrated in Figure 1. Mean percents of proficient trials for the six trainees on 15 tasks evaluated both in the LCCPT and in the aircraft are represented by Xs in the figure, and subsequent aircraft proficient trials by circles. (The tasks excluded from this analysis were those with fewer than four LCCPT trials as identified in Table 2, and Cockpit Procedures.) The solid curve represents a logistic (S-shaped) function fitted to the LCCPT data by the least squares method (see Appendix B for technical details regarding this and other curves discussed below). The fit is quite good, giving a correlation r of .995 between actual percent proficient trials in the LCCPT and those predicted by the equation. As indicated by the level portion of the curve, the subjects reached asymptote (90.8 percent proficient trials) in the device, so extrapolated projections for aircraft performance are also at this level. The first two trials in the aircraft had an average of 81.6 percent proficient trials. Hence, transfer for these two trials was (81.6)/90.8 x 100 = 90 percent. Later aircraft performance exceeded the LCCPT asymptotic value which suggests that either the asymptote was a temporary plateau or the aircraft provided a context for further progress that was not available in the LCCPT. In fact, a separate curve fitted to aircraft data yielded an asymptote of 99.1 percent proficient trials.

A point to note regarding this technique is that unless performance in the device reaches asymptote, performance in the aircraft is projected to be better than in the LCCPT. Thus, with less than asymptotic performance in the device, equivalent performance in the aircraft would actually represent less than 100 percent transfer. A second point regards a distinction between amount learned and percent transferred. As shown later, for example, subjects reached an asymptote of only 86 percent proficient trials for the task Blade Fold in the device but 92 percent (of the 86 percent) of the skill acquired at this task apparently transferred to aircraft performance.

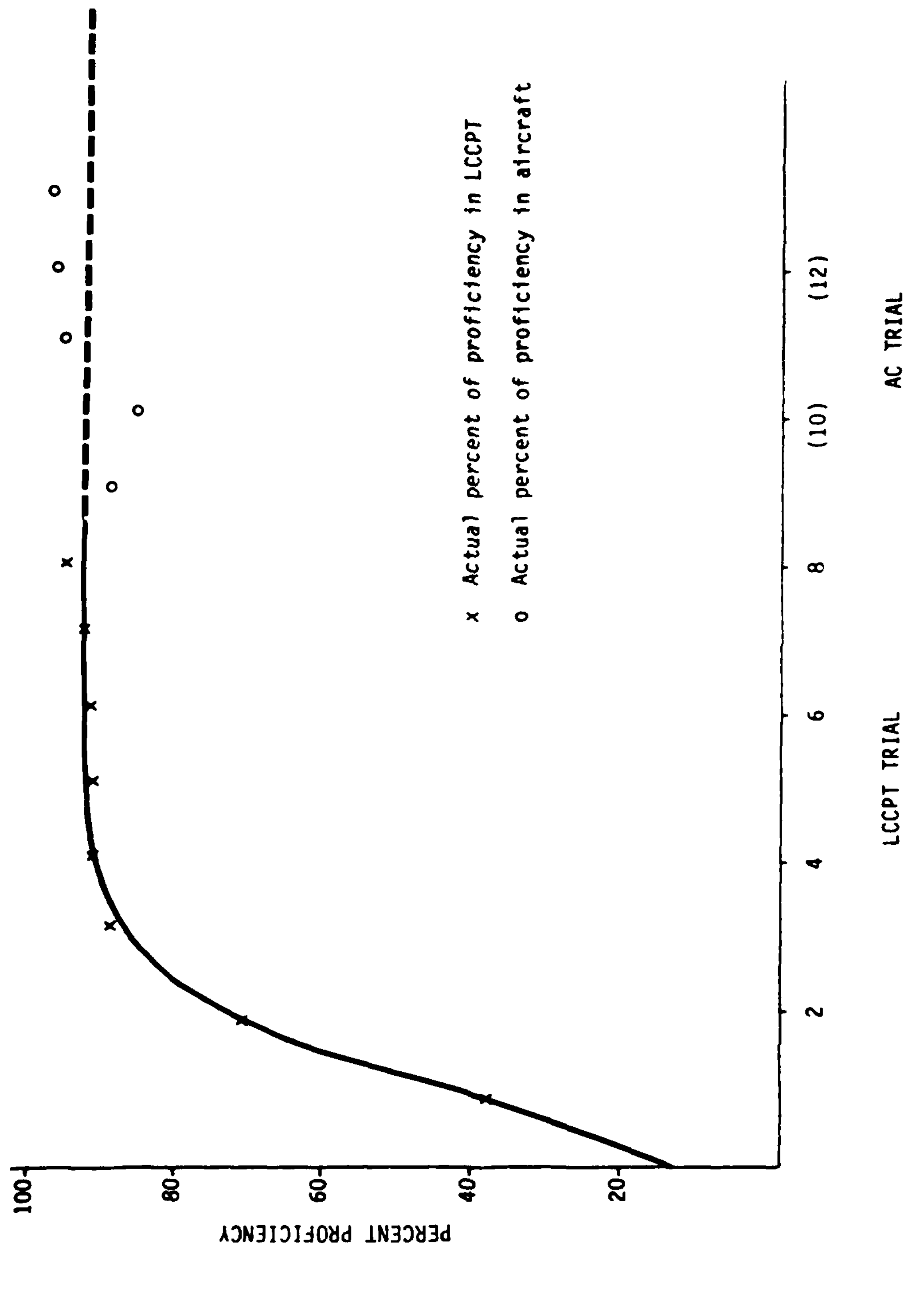

Figure 1. Logistic curve for eight LCCPT trials (solid line) extended through subsequent aircraft trials (dashed line).

Transfer by Task. As stated, only 15 of the 19 specific tasks common to the LCCPT and aircraft had sufficient practice in the device to consider in fitting curves. For 5 of the 15, student performance in the device was 100 percent proficient at least by the second device trial, so curve fitting was unnecessary. The projection of aircraft performance was 100 percent proficient trials for each of the 5. In addition, 1 of the 4 tasks with too few trials for curve fitting, Postflight, was passed on every device trial by every subject. Hence, in spite of the low number of trials, the projection for aircraft performance would be 100 percent proficient trials. (Postflight irspections cannot be performed with the device; during training of that task in the device, the trainee simply described to the instructor what he would do and look for.)

Therefore, meaningful extrapolations of device performance to the aircraft were possible for 16 instead of 15 tasks. These tasks appear in Table 4. They are arranged in order of projected success in the aircraft, that is, extrapolations of the LCCPT acquisition curves for the respective tasks. Projected and actual performance are shown for total aircraft performance, trials 1 and 2 combined, and remaining trials after the first two. The three columns headed "%" show the percents of projected proficient trials that were realized in the aircraft for the three tabulated combinations of trials.

Data in Table 4 reveal several points regarding training with the LCCPT. First, device achievement and later transfer are both low for the task at the bottom of the list, Systems Check. This is because this task had approximately 100 potential items, but less than 20 percent could be performed in the LCCPT. Second, actual and asymptotic or projected performance reached higher levels for tasks that can receive realistic feedback in the device. Note that projected aircraft performance dropped below 95 percent only for Blade Spread, Blade Fold, and Rotor Engagement tasks (plus Systems Check). Realistic feedback in these instances would require visual as well as auditory information not available in the LCCPT. (Engine starts and shutdowns were accompanied by simulated sounds that should occur during these operations, so feedback for these tasks was realistic.) Third, except for Blade Spread, the lowest percent transfer on trials 1 and 2 were for tasks that involved acquiring a cognitive "interface" with the actual equipment. That is, for these tasks, what was done in the aircraft was qualitatively different from what was done in the LCCPT, so mediation was required to equate for two circumstances. (See Spears,[1] especially Chapter V, for a disucssion of this point.) Fourth, following the first two trials when one can assume an interface has been established, percent transfer increased substantially for tasks where it was relatively low at first. In only one case was transfer after the first two trials less than 90 percent of projected performance, and it was below 96 percent for only three tasks. Finally, performance in the aircraft improved substantially on two tasks, Blade Spread and Blade Fold, and to an extent exceeding the LCCPT asymptotic levels. One might infer that the LCCPT, or training practices when using it, could be improved for tasks involving blade manipulations by providing better feedback.

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[1]Spears, W. D. Processes of skill performance: A foundation for the design and use of training equipment (NAVTRAEQUIPCEN 78-C-0113-4). Naval Training Equipment Center, Orlando FL, November 1983.

TABLE 4. ACTUAL AND PROJECTED PERCENT PROFICIENT TRIALS DURING AIRCRAFT TRIALS

Task	AC Total			AC 1-2			AC Remaining		
	Proj.	Actual	%	Proj.	Actual	%	Proj.	Actual	%
Pre T/O CL.	100	100	100	100	100	100	100	100	100
Post Lnd. CL.	100	100	100	100	100	100	100	100	100
Postflight	100	100	100	100	100	100	100	100	100
Taxi CL.	100	98	98	100	100	100	100	96	96
T/O CL.	100	98	98	100	93	93	100	100	100
Post T/O CL.	100	97	97	100	93	93	100	100	100
No. 1 Eng. Sec.	100	96	96	100	92	92	100	100	100
Pre Lnd. CL.	100	95	95	100	100	100	100	92	92
Norm Start	99	91	92	98	86	88	100	94	94
Shutdown	96	95	99	96	86	90	96	100	104
No. 2 Eng. Start	95	93	98	95	86	91	95	97	102
Rotor Dis.	95	90	95	95	79	83	95	96	101
Blade Spread	87	93	107	87	91	105	87	100	115
Blade Fold	86	79	92	86	67	78	86	100	116
Rotor Engage.	83	57	69	83	29	35	83	71	86
Syst. Chk.	82	67	82	82	43	52	82	79	96
Mean	95.2	90.6	94.9	95.1	84.1	87.5	95.2	95.3	100.1

DISCUSSION

The purpose of the initial phase of the study reported here was to determine the training effectiveness of the LCCPT in SH-3H fleet replacement pilot training. The effort was restricted in scope to the existing syllabus for that training and to the use of Category I trainees, i.e., to recent graduates of the helicopter track of Naval Undergraduate Pilot Training. While the syllabus may or may not have been optimal for use with either device, it presumably addressed the objectives of the required training and therefore was appropriate for the evaluation. The restriction of the evaluation to Category I trainees was based upon the assumption that their relatively low level of flight skill and limited experience would provide the most severe test possible of the utility of the low cost device.

On the basis of the results obtained during this Phase I effort, it is concluded that Category I students trained in the LCCPT according to the existing HS-1 syllabus performed as well during subsequent training in the SH-3H helicopter as did those trained in Device 2C44. Trainees using the two devices were generally similar with respect to the amount of flight time required for subsequent completion of A-Stage flight training and the percent of trials performed during that training that were judged by their instructor to meet NATOPS performance standards. The differences that existed in the performance of the two groups were small and overall they did not reach conventionally accepted minimal levels of statistical significance.

Perhaps of greater interest is the fact that LCCPT training of procedural tasks transferred approximately 95 percent to aircraft performance. This figure was derived by comparing proficiency levels in the aircraft with proficiency levels that would have been expected if the aircraft trials had been a continuation of LCCPT trials instead of aircraft trials. It can also be inferred that 2C44 trainees showed a high level of transfer because their trainer and aircraft performance was comparable to that of the LCCPT group.

The estimate of percent transfer was based on only six LCCPT subjects. Nevertheless, the consistency of patterns across tasks indicate that the estimate is quite reliable for trainees such as used in this study. Thus, it is reasonable to conclude that (1) both the 2C44 and LCCPT devices are effective trainers; and (2) the lower fidelity of the LCCPT placed it at no particular disadvantage.

There is another type of issue to be raised, however. Discussion with HS-1 personnel involved in the decision to interrupt the evaluation to modify the device indicated that the decision was made on the basis of flight instructor judgments that the LCCPT was unsuitable for training. In support of their judgments, the instructors cited two factors: (1) the low physical correspondence between some device features and the helicopter simulated; and (2) the need to compensate for the first factor by identifying and emphasizing to the trainees the discrepancies between the device and the helicopter. The instuctors' comments suggested that the decision to terminate the evaluation also may have been influenced by the immediate availability for training of Device 2C44 with its greater physical correspondence to the aircraft.

The validity of these instructors' comments concerning the fidelity of the LCCPT and the need to identify its deficiencies to trainees cannot be challenged. A degree of reduction in physical correspondence to the SH-3H was a factor deliberately accepted in the device's design in order to achieve the goal of reduced device costs. Beyond this consideration, however, it was noted that some features of the device were degraded beyond that believed by HS-1 personnel to be necessary to its low cost design goal. For example, the effects of operation of certain of the LCCPT cockpit controls were judged inconsistent with the effects of corresponding control operation in the aircraft, and the manner of operation of some LCCPT controls was different from corresponding operation required in the helicopter. These discrepancies were particularly annoying to the instructors who felt that they should be corrected before the device received further use. While these features could have been modified (and were modified prior to the conduct of Phase II), they had not been prior to the Phase I evaluation. In the opinion of the project staff, these discrepancies need not be detrimental to the training effectiveness (as opposed to tne fidelity) of the device.

The concern expressed by the instructors over the need to identify and emphasize correct aircraft performance during normal and emergency operation to the trainees being trained in the LCCPT is a different matter. Their concern appears to be based upon a perception that more such explanation is required when instructing in the LCCPT because of that device's lower fidelity than when instructing in Device 2C44. Since the two devices are different, it is to be expected that they must be used differently to achieve comparable training results, even though the same training syllabus was used with both devices. Somewhat greater expenditure of instructor effort in the form of more thorough explanation of aircraft operation when using the LCCPT was expected and apparently was the case.

The process of instructing in any device involves three primary elements: (1) assisting trainees in the association of meaning with the stimuli present in the device (i.e., teaching cue meanings); (2) assisting trainees as they learn to distinguish the cues and responses necessary to correct performance (i.e., teaching cue-response discriminations); and (3) pointing out discrepancies between the device in which training is being conducted and the operational equipment in which performance eventually will take place so that the trainee can concentrate upon practice that will result in positive transfer of training and avoid practice that will result in negative transfer. The instructor's task is made easier, particularly with respect to the third element, if the device is similar to the operational equipment. If the two are dissimilar, the instructor will be required to attend more to the discrepancies and to provide more explanation to the trainee to guide his learning of correct cue meanings and cue and response discriminations. If the device and the transfer vehicle are highly similar, as is the case with many very high fidelity simulators of operational aircraft, little instructional effort directed toward operation of the aircraft is required, and instructors are free to concentrate on other matters. Because of this relationship between device fidelity and instructor effort, instructor effort must be considered one of the factors to be traded off in achieving the lower cost goals of the LCCPT design where reduced fidelity is involved.

Nevertheless, the question arises as to whether the increased demands upon the instructors during use of the LCCPT are reasonable. The question cannot be totally resolved on the basis of the present study. It is noted, however, that the data show the process of instructing in the LCCPT required no more time than did comparable instruction in Device 2C44, and the number of trials performed by the two groups during that instruction was approximately equal. To the extent that the time required to conduct training in the LCCPT can be taken as a measure of instructor workload, the demands made upon the instructors do not appear to have been unreasonable.

Although very few significant differences were found in the performance of the two groups trained in this study, this result may possibly be attributed to a lack of precision or reliability in the performance measurement system employed. The data the system yielded reflect the judgments of instructors as to whether a particular performance met a particular standard. The qualification of the instructors to make such judgments is widely accepted within the Navy. Nevertheless, since the performance evaluation system employed has not been examined to establish its statistical reliability, the possibility that low evaluation system reliability could be a factor in the results obtained must be acknowledged.

In any case, the availability of data for only six subjects limits the precision with which generalizations regarding training effectiveness to other students and programs can be made. Nevertheless, the success with these subjects clearly demonstrated that effective training with the LCCPT is feasible. And although the HS-1 instructors found unacceptable characteristics in the LCCPT, fortunately the serious ones could be and were corrected. The serious problems were (1) engine responses, to engine failure or speed selector and collective movements, for example, that were too slow or opposite in effect relative to aircraft responses; (2) inaccuracy of Automatic Stabilization Equipment responses to trim and cyclic inputs; and (3) too great a movement required to reach idle detent on the speed selector quadrant (the same magnitude of movement resulted in engine shutdown in the aircraft).

In spite of the concern over the fidelity of the LCCPT expressed by the instructors and constraints on this study, the fact remains that the LCCPT was found to be an effective training device. Continued development and evaluation of the low cost device design concepts embodied in the LCCPT thus appear warranted.

PREPARATION FOR PHASE II

Upon termination of the Phase I training effectiveness evaluation of the LCCPT, the device was returned to its developer for planned continued development of the device's self-instructional and performance measurement features. While this effort was underway, additional modifications were made to the device that were intended to increase its physical and functional correspondence to the SH-3H helicopter. The comments of the HS-1 flight instructors who participated in the Phase I evaluation and reviews of the device by personnel from HS-10 largely determined the modifications that were made. Most significant of these modifications was replacement of the device's simulated engine power control quadrant with an actual SH-3H quadrant. Other changes involved "tweaking" the device's responses to control input to make those responses more consistent with the flight instructors' comments concerning the performance of the aircraft.

In all instances, the trainer modifications were in the direction of increasing the "fidelity" of the LCCPT and improving its performance measurement and instructional features. There was no reason to assume that they could adversely affect the training effectiveness of the device. On the contrary, if there was any effect at all upon training, it was assumed that the effect would be in the direction of enhanced effectiveness. Therefore, the training value of the LCCPT following these modifications should equal or exceed that determined during the Phase I evaluation.

SECTION III

THE SELF-INSTRUCTIONAL FEASIBILITY DEMONSTRATION

PURPOSE

The purpose of the LCCPT Phase II effort, which was conducted at HS-10, NAS North Island, California, was to demonstrate the use of the LCCPT in a program of instruction in which the role of the flight instructor in the conduct of that instruction was limited.

OVERVIEW OF SH-3H TRAINING AT HS-10

Training of SH-3H fleet replacement pilots at HS-10 was comparable in most respects to similar training conducted at HS-1. The primary differences relevant to the present LCCPT evaluation were the absence of Device 2C44 or any other CPT at HS-10 and the amount of device training included in the syllabus.

Prior to introduction of the LCCPT, device training at HS-10 consisted of cockpit procedures training conducted in an Operational Flight Trainer, Device 2F64B. During their training, each Category I trainee was scheduled to receive four two-hour periods of instruction (AW-1 through AW-4)and a two-hour check flight (AW-5X) for a total of ten hours of instruction and checking in Device 2F64B. The actual duration of each period in the device varied. During all such instruction, the trainee occupied the pilot's seat of the trainer. A second Category I trainee, when available, occupied the copilot seat during AW-1 through AW-5X and performed copilot duties. All device instruction was conducted by a flight instructor.

Training in Device 2F64B was followed by A-Stage flight training which involved six scheduled training flights in the SH-3 helicopter (AF-1 through AF-6X). The average duration of each flight at HS-10 was approximately three hours.

Ground instruction, consisting mostly of instructional modules designed for individual study in learning carrels, was intermixed with the device and early flight training. Much of the information students were required to learn about the SH-3H and the performance of its various systems was contained in these modules, and the information was generally presented to students on a schedule such that specific systems information would have been covered prior to needs for its use in the device or in the aircraft. The instructors reviewed and supplemented the systems information during the training conducted in Device 2F64B and in the aircraft.

FACTORS INFLUENCING SELF-INSTRUCTION IN THE DEVICE

During planning for Phase II, three principal factors were identified that would affect the demonstration of reduced dependence upon the flight instructor during training in the LCCPT. These factors were: (1) the extent to which the computer aided instructional features of the device would permit the training to be self-administered by the trainee; (2) the training program or syllabus employed with the device; and (3) the attitude of the trainees, the instructors, and other HS-10 personnel toward the device and toward the concept of a reduced role for the flight instructor during device training. These factors are discussed below.

LCCPT SELF-INSTRUCTIONAL FEATURES. The LCCPT and its self-instructional features are described in the previously cited design documents prepared by the device developer. For the convenience of the reader of the present report, the principal features of interest during Phase II of the demonstration are identified below. For further information about these features, the design documents should be reviewed or the device inspected.

Device Set-Up Features. The device is designed so that a trainee can initiate a training activity provided only that the device has been powered up. The power-up function normally would be performed each day by a maintenance technician or other designated individual prior to scheduled training periods. To initiate training, the trainee "signs in" at an alphanumeric keyboard by answering questions presented on a cathode ray tube (CRT), e.g., What is your social security number? Are you an instructor? His responses to such questions ready the LCCPT for training and to record the progress of the trainee as he practices a series of procedural tasks.[1]

Training Program Presentation Features. The LCCPT incorporates a series of cockpit procedural tasks that must be learned. These tasks include the normal and emergency checklist procedures to be performed during SH-3H pre-flight cockpit checks, during engine start and shutdown, and when responding to engine, electrical system, and hydraulic system malfunctions in the aircraft. The cockpit procedures that can be practiced in the LCCPT cover essentially the full range of normal and emergency checklist procedures specified in the NATOPS manual for the SH-3H helicopter.[2]

Procedural tasks to be practiced may be selected by the trainee or can be selected for him by the LCCPT, based upon his previous performance in the device. Once a procedure has been selected for practice, the CRT instructs the trainee concerning any control or switch position adjustments that must be made before the procedure should be begun, and monitors his repositioning of each. When the necessary control adjustments have been made, the selected cockpit procedure may be performed by the trainee, with his performance monitored by the device. Upon completion of the procedure, or its termination if

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[1]If certain of the device-controlled lesson presentation and performance recording features described below are to be employed, a record file must be created in the device's computer memory for the trainee prior to his first use of the device. This administrative function would be completed off-line and would not be part of the procedure required to set up the LCCPT for each day's training.

[2]Since the LCCPT does not incorporate a visual display system or radio communication/navigation simulation, procedures that depend upon such features cannot be performed in the device.

the trainee elects, a new procedure will be selected, and training will proceed as described above. At the conclusion of the time allotted for such training, the trainee may terminate the training period.

Performance Monitoring and Feedback Features. The performance of procedural tasks by the trainee may be monitored automatically by the LCCPT. When this device feature is employed, the errors committed during each task (i.e., step omission, steps performed out of sequence) and the time required to complete the procedure are recorded and displayed on the CRT for feedback to the trainee. In addition, those error and time data are tabulated to show trainee progress. The tabulation indicates the number of times each procedure has been practiced, the number of times each task was performed correctly, the number of errors made on each of the last four trials, and the time required to complete the most recent trial. These data, which may be displayed at any time upon call by the trainee or an instructor, are tabulated both to reflect individual trainee progress as well as his progress with respect to a designated group of other trainees, e.g., his class, undergoing the same training.

THE SELF-INSTRUCTIONAL TRAINING PROGRAM. A training syllabus was developed for use with the LCCPT that would limit the involvement of the flight instructor in the conduct of that training. A conceptual goal of the development effort was to eliminate the instructor altogether, but two considerations necessitated a more limited goal to be adopted. These considerations were (1) the strong desires of the instructors at HS-10 to remain active participants in all phases of student training and their belief that such involvement should be required; and (2) problems with the self-instructional features of the device. The former consideration will be discussed later. The latter consideration is related to the developmental nature of the self-instructional features of the device and the failure of the program logic to deal adequately with all procedure selection and performance evaluation situations that were expected to arise during use of the LCCPT.[1]

A constraint upon the LCCPT self-instructional syllabus was that training on the device had to occur during the calendar time (10 working days) normally scheduled for Device 2F64B training sessions AW-1 through AW-5X in the existing HS-10 syllabus. In addition, to the extent that flight instructors were to be involved in LCCPT training, it was desirable that their involvement be at times that did not conflict with their other scheduled activities. Thus, it was important that the LCCPT self-instructional syllabus parallel the syllabus employed previously with Device 2F64B wherever feasible.

The LCCPT Self-Instructional Syllabus. The principal differences between the self-instructional LCCPT syllabus and the existing 2F64B syllabus were: (1) the addition of a group "orientation" session; (2) the absence of an instructor during certain training sessions; and (3) the provision for unlimited practice in the trainer.

[1]The self-instructional features of the device have been developed further since this evaluation.

The self-instructional syllabus developed for the LCCPT consisted of five sessions, designated CPT-1 through CPT-5X, each scheduled to be of two hours' duration.[1] Prior to this training, a group "orientation" session was scheduled for trainees. During this session, the purpose of the evaluation was described, an amplified SH-3H cockpit procedures checklist (described below) was distributed, and the trainees were briefed concerning use of the self-instructional features of the device. During CPT-1, the flight instructor initiated the practice of normal cockpit procedures to two trainees in the LCCPT. Practice of these normal procedures continued during CPT-2, but with the instructor absent. During CPT-3, emergency cockpit procedures practice was initiated by the instructor, and that practice continued during CPT-4, again with the instructor absent. CPT-5X served primarily as a check flight, although some instructional activity was permitted if necessary to assure completion of the required practice of the procedures of interest. CPT-5X was identical in content and format to AW-5X, the check flight conducted in Device 2F64B in the existing HS-10 training program.

During sessions CPT-2 and CPT-4, trainees practiced the procedures introduced during preceding sessions. Because the scheduled two-hour duration of CPT-1 and CPT-3 did not permit all of the required normal and emergency procedures to be introduced during those periods, some of the procedures practiced during CPT-2 and CPT-4 were "introduced" to the trainees by themselves rather than by instructors. It should be noted that the trainees were permitted to pace themselves during these self-instructional activities. As an apparent consequence, the two hours scheduled for each of the two self-instructional sessions were insufficient, and the trainees were encouraged to schedule additional practice sessions (e.g., CPT-2a, CPT-2b, etc.) if they judged such additional sessions were needed. The amount of additional practice time they could schedule was limited only by the availability of the device.

<u>Trainee Pairing</u>. For purposes of LCCPT training, the trainees were paired, and the paired trainees were scheduled together for each of sessions CPT-1 through CPT-4. One of the trainees occupied the pilot seat, the other the copilot seat. At points of their own choosing during each training session, the trainees changed seats, thus dividing their practice of the pilot's tasks on the basis of their perceived relative need for such training. Separate CPT-5X check flight sessions were scheduled for each trainee.

The trainee occupying the copilot seat performed copilot tasks required in the execution of the procedures practiced. In addition, he served as a peer instructor during training sessions not attended by an instructor pilot. When so serving, he operated the LCCPT instructor console (i.e., the alphanumeric keyboard and CRT display), selected tasks to be practiced by the trainee occupying the pilot seat, and referred to the amplified checklist and other resource material as needed. His role as a peer instructor was guided by the self-instructional features of the LCCPT described above, as well as by any special instructions that had been given him by the flight instructor who was responsible for overseeing his progress.

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[1] The discussion of the syllabus presented here describes the intended use of the LCCPT during the demonstration. Variations from that use which occurred during the demonstration are described subsequently.

Role of the Instructor. The intended role of the flight instructor in LCCPT training was determined through negotiations with cognizant personnel at HS-10. That role consisted of: (1) introduction of the students to the device and its self-instructional features, i.e., device sign-on and operation; (2) the initiation of student practice of normal cockpit checklist procedures; (3) the initiation of practice of abnormal or emergency checklist procedures; and (4) the conduct of the CPT-5X check flight in the device to assure that the trainees were competent in the performance of the required cockpit procedures before they were permitted to proceed to the aircraft for the inflight phase of their training. In addition, the instructors were available to respond to trainee questions when the device was being used for self-instruction (flight instructor offices were adjacent to the area in which the device was located, and trainees had access to them).

Amplified Checklist. A concern of the HS-10 flight instructors was the trainees' need for systems information during procedures training in the LCCPT. A major instructor function during training in Device 2F64B was to evaluate the trainees' knowledge of SH-3H systems functions and related information, and, if it was deficient, to provide additional instruction to remove detected deficiencies. In the absence of a flight instructor during training in the LCCPT, other provisions had to be made for the trainees to obtain the necessary systems functions information.

To meet the need for such information, an expanded or amplified SH-3H normal and emergency procedures checklist was developed. The amplified checklist identified the steps to be performed in the execution of each procedure for which training in the device was intended, the cues that preceded and followed execution of each step, and the systems functions information that was relevant. Examples of procedures described in this amplified checklist are contained in Appendix D. Two examples are presented: one for a normal procedure, and one for an emergency procedure.

The amplified checklist was given to each trainee at the time of the initial group orientation session, with instruction that they familiarize themselves with its content and format. The amplified checklist was then used by the trainees as required during training in the LCCPT to obtain information about the procedures being practiced and the aircraft systems involved. During that training, the trainees had access to the NATOPS manual for the SH-3H helicopter, and they were permitted to bring to the training session any other reference material they wished. It should be noted that the NATOPS Normal and Emergency Procedures Checklist for the SH-3H helicopter was used during practice of the procedures trained in the device. However, during LCCPT training, they were encouraged to make maximum use of the device rather than to attend extensively to reference sources other than the amplified checklist. The amplified checklist was developed as a supplemental reference source while training, not as a substitute for the required NATOPS checklist.

ATTITUDES TOWARD SELF-INSTRUCTION. A major concern during planning for the reduced role of the flight instructor during training in the LCCPT was the acceptability of such a role. Flight instructors are generally acknowledged to be an essential part of the pilot training process, regardless of whether that training is conducted in the aircraft or in an aircraft simulator or other training device. Suggesting that training could be conducted with less

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Early in the project, steps were taken to alleviate any misgivings the flight instructors at HS-10 might have about the planned demonstration. A flight instructor from HS-10 was invited by the Navy to participate in LCCPT design reviews conducted by the device developer, and input was solicited from him concerning the fidelity of the simulation of the procedural tasks to be practiced in the device. HS-10 pilots also participated in the in-plant acceptance tests of the LCCPT. In addition, plans for conduct of the demonstration were discussed with all the HS-10 flight instructors who were available for such discussions during a visit by the project staff to HS-10 prior to initiation of the demonstration effort. Drafts of the amplified checklist were reviewed with these instructors, and their input to its format and content was solicited and incorporated into the final version.

After the device was delivered to HS-10, time was devoted to familiarization of the flight instructors who were to participate in the planned demonstration with LCCPT features and with the planned syllabus. The instructors were invited to participate in mock training sessions during which they role-played the part of trainees being checked out on the LCCPT and practiced cockpit procedures on it. A project staff member served as the "flight instructor" during the initial instructor orientation sessions, and the HS-10 LCCPT Project Officer did so during later sessions. The instructors were permitted unlimited time on their own to try out the device's self-instructional features and to verify the accuracy of the task simulation available in the device.

As a consequence of these efforts, and the additional familiarity with the device and the self-instructional syllabus gained through training the initial groups of students, the attitudes of HS-10 instructors and other personnel toward both the device and the self-instructional syllabus were generally positive. It should be noted that those attitudes became increasingly positive as the demonstration progressed. By the end of the formal demonstration, the majority of the participating flight instructors were judged to be advocates of LCCPT training and appeared to be amenable to some reduction in their role in that training.

The attitudes of the trainees toward self-instruction in the LCCPT reflected the positive attitudes of the instructors. Although the trainees were frustrated by design inconsistencies and frequent failures of the device's self-instructional features, they were able to work around the problems encountered without major difficulty. There was unanimous expression of acceptance by the trainees who participated in the demonstration of the LCCPT and of the concept of instruction in the absence of a fully qualified flight instructor during practice sessions. In fact, the trainees responded with enthusiasm to the opportunity to use the device for practice without the presence of the flight instructor.

APPROACH

The approach followed in demonstrating the use of the LCCPT consisted of three sequential steps. During the first step, the self-instructional syllabus program and the amplified checklist were developed. The development was accomplished by the project staff with input from and review by HS-10 personnel as just described.

The second step involved the introduction of the LCCPT to the instructors at HS-10 and their familiarization with the syllabus and with the instructional approach to be taken when they were absent from the trainer. These activities also were described earlier.

The third step involved the demonstration itself. During this activity, three groups of trainees (all Category I trainees in Classes H-3, H-4, and H-5) underwent training in the device, and the instructors progressively removed themselves from the instructional process as their confidence in the device and the self-instructional approach increased. During the training of Class H-3, which consisted of only two Category I trainees, the instructors participated in almost all device training sessions and tended to function in a traditional manner, i.e., as they were accustomed to functioning during training in Device 2F64B. The self-instructional syllabus was followed in general, but the instructors tended to function in ways more appropriate to the more familiar 2F64B syllabus. Even with this initial group, however, the self-instructional features of the LCCPT were frequently employed by the instructor to select procedures to be practiced and to record trainee performance. Each individual instructor was permitted by the HS-10 Training Officer to determine the extent of use of the self-instructional syllabus and of his participation in the instructional process, while at the same time he was encouraged to withdraw from that process whenever possible.

When the second group of trainees (four Category I trainees from Class H-4) was trained in the device, the instructors relied to a greater extent upon the self-instructional features of the device and upon the self-instruction concept. They were less active in the instructional process than they had been with the initial group of trainees. The self-instructional syllabus was generally followed. During much of the time, particularly when new procedures were not being introduced, the instructors acted primarily as observers and sources of information to the trainees when information was solicited. Again, the instructors were encouraged to rely more upon the self-instructional features of the device and to employ the self-instructional syllabus, but were free to participate in the instructional process whenever they wished.

When the third group of trainees (four Category I trainees from Class H-5) were trained in the device, the instructors had gained sufficient confidence that they generally followed the self-instructional syllabus and withdrew from the area in which the device was located during sessions CPT-2 and CPT-4. Thus, with one significant exception, the LCCPT was employed more nearly in the manner intended by the syllabus during the training of the third group, with the participation of the instructors reduced primarily to that required for the introduction of trainees to the device, the introduction of training on normal and abnormal procedures, and the conduct of the check flight that concluded the LCCPT phase of training. A significant number of normal and emergency procedures were practiced by trainees without those procedures having been introduced previously by a flight instructor, and most of the repeated practice of previously introduced procedures that was necessary to build required skills took place in the absence of a flight instructor.

The one exception to following the syllabus in using the LCCPT, referred to in the preceding paragraph, occurred during sessions CPT-1 and CPT-3. Since no more than four trainees were involved in each of the three groups trained, and since, if the syllabus were strictly followed, each training session would involve two trainees, only two instructors were required. However, it was the desire of HS-10 personnel that a larger number of flight instructors participate in the demonstration in order to become familiar with the LCCPT. Since it was necessary to involve extra instructors, in some instances CPT-1 and CPT-3 were conducted more than once for some pairs of trainees, or these sessions were conducted for a single trainee with the instructor occupying the copilot seat and the entire scheduled two-hour session devoted to the "introduction" of the required normal or emergency procedures to a single trainee.

Six flight instructors participated in these training activities. They were selected to participate by the HS-10 Training Officer. They varied from relatively junior to relatively senior in terms of their experience as flight instructors at HS-10. The project staff conducting the demonstration had no involvement in the selection of these instructors or in the number selected.

FINDINGS

The purpose of the Phase II LCCPT effort conducted at HS-10 was to demonstrate that self-instruction in the device was a feasible concept. Feasibility depends upon whether (1) the resources are available to support the training; (2) the training achieved is adequate; (3) the training is administratively manageable; and (4) instructor involvement could be reduced. These four considerations are discussed below.

RESOURCE AVAILABILITY. The facilities and personnel resources available at HS-10 to support Category I fleet replacement pilot training in the LCCPT were sufficient during the demonstration described in this report. An area for housing the trainer was available, and it was conveniently located with respect to trainee and instructor access.[1] Squadron personnel were adequately skilled to operate the device. Maintenance support was to be provided as needed by the LCCPT developer.

The LCCPT was housed in an area that was secured during off-duty hours, and access to it was restricted during those hours. This restriction was of no consequence during the present demonstration. However, had larger numbers of trainees been involved, it may not have been possible for all of them to access the trainer as frequently as they might have wished for self-instructional purposes. If large numbers of trainees are to be involved in future classes, this restriction could adversely affect the self-instructional use of the LCCPT.

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[1]At the time of the demonstration described here, another training device was located in the same area, and the LCCPT could not be used when the other device was in use. Consequently, coordination of the two device training schedules was necessary.

ADEQUACY OF TRAINING. To be acceptable, the results of the LCCPT training received by HS-10 trainees would have to be reflected in satisfactory performance during the CPT-5X check flight in the LCCPT and in the helicopter during A-Stage flight training. The Phase I evaluation of the LCCPT, conducted at HS-1 and described earlier in the report, had determined that individual tasks trained in the device will transfer to the aircraft as well as will tasks trained in a higher cost device. This fact having been established, the scope of the Phase II effort was directed toward more global indices of training effectiveness than transfer of individual task performance.

The indices of interest were (1) flight instructor evaluation of trainee performance during the CPT-5X check; (2) flight instructor evaluation of trainee performance during training in the helicopter; and (3) the flight training time required to complete the required aircraft training. Because the self-instructional syllabus was more nearly followed during the training of the third group (Class H-5), the data for that group only were used to evaluate the effectiveness of the training conducted in the device during the demonstration described here.

<u>Instructor Evaluation: CPT-5X</u>. The level of proficiency the trainees demonstrated during the CPT-5X check flight is an indication of the effectiveness of their self-instruction. None of the trainees in Class H-5 received a "down," i.e., an unsatisfactory rating, on that examination in the LCCPT. Using the four-point rating scale described earlier, the average rating of these four trainees on CPT-5X was 3.08. The range of individual ratings was from 2.90 to 3.31. The squadron average for such ratings was reported to be 3.00.

<u>Instructor Evaluation: Flight</u>. With respect to instructor evaluation of trainees performance during the flight training that followed training in the LCCPT, information was available from two sources--interviews with the flight instructors who conducted the inflight training, and the grade slips prepared by these pilots at the conclusion of each training flight. To obtain oral reports of student performance in flight, HS-10 flight instructors who had not participated in the LCCPT training efforts but who had flown with the LCCPT-trained trainees during one or more of the training flights in the helicopter (i.e., AF-1 through AF-6X) were interviewed. These instructors were asked for their assessment of the readiness for flight training of the LCCPT trainees when compared with earlier trainees who had received cockpit procedures training in Device 2F64B.

Without exception, these instructors indicated that the pilots trained under the self-instructional syllabus were indistinguishable from conventionally trained pilots so far as their performance during AF-1 through AF-6X was concerned. While some concern was expressed that the absence of a flight instructor during device training deprived the trainee of additional exposures to a pilot role model and thus might adversely affect his decisiveness in the aircraft, there was a consensus that any such deficiency in trainee performance could be overcome in the aircraft during the inflight portion of fleet replacement pilot training.

Each maneuver and procedure performed by a trainee during AF-1 through AF-6X is rated by the flight instructor at HS-10 using the same four-point scale used during Naval Undergraduate Pilot Training and described earlier. By summing the points assigned to the maneuvers and procedures performed during a particular training flight and dividing that sum by the number of maneuvers and procedures performed, a mean grade for each flight may be derived. These individual flight grades may then be averaged for each trainee and for the group as a whole. The mean flight grade for all trainees in Class H-5 was 3.02. The range of these mean grades was from 2.92 to 3.11.

One of the trainees received an Unsatisfactory rating on one maneuver (Single Engine Operation) during his AF-6X check flight. As a consequence, his check flight was given a "down," and he was required to repeat this check with another flight instructor. His performance on the recheck was satisfactory, and the flight received a mean grade of 3.00 on the maneuvers and procedures performed. No other "downs" were received by any of the trainees in this group on any of their training flights. HS-10 training personnel stated that one "down" check flight in a class is not an unusual event, and they expressed little concern over the occurrence.

Training Time. With respect to flight training time, the mean time logged by Class H-5 trainees during AF-1 through AF-6X was 18.5 hours, which is typical of flight training time at the squadron. The range of times was from 17.1 hours to 21.6 hours. The 21.6 hour high was logged by the individual who was required to repeat his check flight. The repeated flight added 3.4 hours to his flight time total.

Summary. On the basis of flight instructor comments, the performance ratings they assigned in both the LCCPT and in the helicopter, and the flight time required for conduct of the inflight portion of the training, the results of the LCCPT self-instruction must be judged acceptable. These trainees appear to be prepared to a degree comparable to conventionally trained personnel to proceed to the inflight phase of their training.

MANAGEABILITY OF LCCPT SELF-INSTRUCTION. A primary indication of the manageability of the self-instructional syllabus was the extent to which it was or could be followed during the demonstration. In general, the LCCPT training proceeded according to that syllabus as it is described above. However, there were two significant deviations from the syllabus that had not been anticipated. First, the abundance of instructors resulted in more instructor-student contact than was planned. Rather than instructing two trainees during CPT-1 and CPT-3 and having them change positions halfway through the period, an instructor conducted separate CPT-1 and CPT-3 sessions for each trainee. The consequence of this procedure was to double (approximately) the flight instructor time required for the conduct of those sessions over that indicated by the syllabus.

The second deviation was brought about by the trainees themselves. Since they were informed during the group orientation session that preceded CPT-1 that they could use the device for self-instruction whenever it was not scheduled for other purposes, they proceeded to do so. Three of the four trainees in Class H-5 began this training in the device prior to CPT-1, and two of them continued their practice in it after completing their CPT-5X check flight. Additionally, whereas the self-instructional syllabus involved fixed pairing of trainees and the conduct of peer instruction, trainees practiced in the LCCPT paired with any other trainee available at the time rather than with the ones with whom they had originally been paired, or, if no other trainee was available, they practiced alone.

As a consequence of these unanticipated uses made of the LCCPT during the evaluation, a strict evaluation of the planned self-instructional syllabus did not take place. What did take place, however, was an assessment of the trainees' ability to derive training benefit from the device with a reduced dependency on the flight instructor, and to manage the scheduling and conduct of that training. This deviation from the planned syllabus did not adversely affect the demonstration, but rather it tended to illustrate the robustness of the self-instructional concept embodied in the syllabus.

FLIGHT INSTRUCTOR INVOLVEMENT. The planned self-instructional syllabus called for approximately 4 flight instructor contact hours per pilot trainee, i.e., per trainee occupying the pilot seat in the LCCPT. The time was planned to be distributed between CPT-1 (1 hour), CPT-3 (1 hour), and CPT-5X (2 hours). Because of the number of flight instructors who participated in the demonstration and their desire to conduct each of these sessions as often as they could, the time devoted to each pilot trainee in CPT-1 and CPT-3 approximately doubled that which was scheduled. The mean instructor contact times for the four trainees in Class H-5 were 1.8 hours for CPT-1, 2.2 hours for CPT-3, and 2.2 hours for CPT-5X. The mean total instructor contact time was 6.2 hours for the four trainees.

The instructor involvement in the instructional process for the trainee in Class H-5, then, was reduced from the 10 hours per trainee scheduled in the earlier 2F64B syllabus to approximately 6 hours. While not as large a reduction as had been projected, i.e., from 10 hours to 4 hours, it is nonetheless significant from a practical standpoint. Such a reduction in dependence upon a flight instructor would grow in importance, of course, as the number of trainees increased.

It should be noted that the initial orientation conducted for the class also involved instructor-student contact. While 1 hour was scheduled for this group activity, a time sufficient to accomplish the objective set for the group session, 1.7 hours were spent orienting the four members of Class H-5. This time is not included in the instructor contact hour averages cited above because instructor pilot skills were not actually required. Had it been included, the mean total time for each trainee would have been increased proportionately, i.e., by approximately 25 minutes each.

The self-instructional syllabus permitted session CPT-2 and CPT-4 to be repeated as many times as the individual trainee judged to be necessary for his own skills to reach criterion levels of proficiency. The number of repetitions of these two sessions varied from 3 to 5 for CPT-2, and from 1 to 5 for CPT-4. The mean total time spent during these repetitions was 8.1 hours for CPT-2 and 8.2 hours for CPT-4, for a total of 16.3 hours of self-instruction.[1]

The total average time devoted to training in the LCCPT may be obtained by adding the time devoted to self-instruction during CPT-2 and CPT-4 (16.3 hours) to the average time previously indicated for instructor contact with the trainee during CPT-1, CPT-3, and CPT-5X (6.2 hours). The mean total average LCCPT training time is 22.5 hours for the four trainees in Class H-5. This is 12.5 hours more instructional time than had been scheduled for Device 2F64B in the syllabus that preceded introduction of the LCCPT. If the self-instructional time spent in the LCCPT prior to CPT-1 and after CPT-5X is added (4.1 hours), the mean device time becomes 26.6 hours, or 16.6 hours more than was scheduled in Device 2F64B.

CONCLUSION

On the basis of the evidence reviewed above, the feasibility of an LCCPT cockpit procedures training program in which trainees assume a degree of responsibility for their own instruction was successfully demonstrated. The trainees successfully managed their self-instruction and practice on the device during those periods when the flight instructor was absent. In doing so, they appear to have been able to identify those cockpit procedures needing additional practice and to develop the required levels of proficiency on each. Considering the mean total time spent in self-instruction, it is suspected that trainees may have practiced more than necessary; at least they did not tend to underestimate their need for practice.

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[1]The amount of time devoted to self-instruction during CPT-2 and CPT-4 was reported by the individual trainee on record forms provided for that purpose. The accuracy of these self-reports cannot be verified, since some of the training occurred when observers were not present.

SECTION IV

CONCLUDING COMMENTS

Cockpit procedures training devices are in common use in military and civilian pilot training programs. The most frequent basis for their use is that they make possible training that otherwise would have to be conducted in flight simulators or in aircraft. Thus, their use makes simulators and aircraft available for other training or operational activities.

Another basis for the use of CPTs is that training in them is generally less expensive than training in flight simulators or in aircraft. CPTs are relatively simple devices as compared to flight simulators and aircraft and, consequently, are less expensive to acquire. They are not necessarily less expensive to operate for training, however, An instructor is usually still required to conduct the training, whether in a CPT, a flight simulator or an aircraft. The purpose of the present effort was to examine these two factors that affect the expense of pilot training in CPTs, i.e., the cost of acquiring the device, and the requirement for an instructor to conduct training in it.

In an effort to reduce CPT acquisition cost, the Navy developed a "low cost" CPT. In the effort reported here, a transfer of training study was conducted in which the aircraft performance of trainees trained in the low cost device was compared with that of trainees trained on Device 2C44, a conventional high cost device. It was found that the two devices were essentially equal with respect to their training value, and that transfer to the aircraft was substantial for tasks that were trained in the devices.

It should be noted that the effort reported here did not include a systematic study of all, or perhaps even the principal, factors that determine whether lower cost CPT design concepts can lead to useful training. The effort examined only one example of a low cost CPT design. Undoubtedly, many other "low cost" CPT designs are possible, and some would be significantly lower in cost than others.1 Since the present effort has found that one specific low cost CPT design has training value, examination of other even lower cost designs would seem warranted.

With respect to the requirement that CPT training be conducted by an instructor, the present effort demonstrated that this requirement is subject to some moderation. A syllabus was developed in which the dependence upon an instructor for the conduct of pilot training in the low cost device was significantly reduced, and the feasibility of use of that syllabus in a Navy fleet

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[1] For descriptions of other low cost cockpit training devices, see:

Prophet, W. W., & Boyd, H. A. Device-task fidelity and transfer of training: Aircraft cockpit procedures training (Tech. Rep. 70-10). Alexandria, VA: Human Resources Research Organization, July 1970.

Caro, P. W., Jolley, O. B., Isley, R. N., & Wright, R. H. Determining training device requirements in fixed wing aviator training (Tech. Rep. 72-11). Alexandria, VA: Human Resources Research Organization, April 1972.

replacement training squadron was demonstrated. It should be noted here as well, however, that the demonstration did not systematically explore the full range of factors influencing the design and administration of a self-instructional CPT syllabus. Rather, it demonstrated the feasibility of one approach to training that reduced the involvement of an instructor in that training. In view of the success of the present demonstration, efforts to develop syllabi that would be even less dependent upon instructor availability during CPT (or even flight simulator) training should be pursued.

APPENDIX A

LOW COST DESIGN CONCEPTS[1]

Design characteristics which are responsible for savings are the result of conscientious applications of rather pedestrian design concepts. Generally, the design concepts indicate that training systems should include: (1) only features essential for achieving the training objectives; and (2) instructional aids that facilitate the learning. Significant contributions to achievement of the low cost goals are found in day-to-day implementations of the low cost design concepts in the face of a variety of problems associated with computer automation and field settings.

Analyses were performed to include in the training system only the minimal features required to satisfy the training objectives. To accomplish this, discussions were held among human factors personnel, engineers and subject matter experts in which efforts were made to determine certain cost-saving features, as listed below, that could be implemented for each training task, with no loss in training effectiveness. These analyses resulted in simulation fidelity levels that are lower than those of conventional systems.

COST SAVING FIDELITY FEATURES

- Elimination of redundant capabilities
- Approximate (vice exact) cockpit dimensions
- Chairs vice aircraft-type seats
- Photographs vice panels
- Compressed instrument faces
- Restricted needle movements
- Discrete vice smooth needle movements
- Silk screen instrument faces
- Malfunctions that give onset cues but not progressive degradation
- Limited flight dynamics

In reference to these features, a malfunction needs to be simulated only with one engine if required operator responses to the same malfunction in the

[1]Taken with minor editing from:

Blaiwes, A. S. Low-cost aircrew-training systems. Proceedings of the Fourth Interservice/Industry Training Equipment Conference, Orlando, Florida, November 1982.

other engine are the same. Simulation of the various engine malfunctions would be distributed among all engines, however. This also applies to hydraulics, fuel tanks, generators, etc. The approximate cockpit dimensions of the low cost systems were not noticeably different from more exact (and costly) constructions. Tasks could be learned as well using chairs instead of more expensive seats. In many cases, photographs of a panel were as useful as more realistic panels. Graduations on instrument faces could be compressed imperceptibly and the full range of needle movement could be reduced for some tasks to help restrict needle movements to 270 degrees (allowing the use of a D'Arsonval meter movement rather than more expensive servo mechanisms). Discrete needle movements could be used instead of smooth movements, where the dynamics of the movement were not important cues for action. (Trainer cockpit indicators do not have to move as far or track in the identical manner as the aircraft indicators if these characteristics are not essential cues, as determined in discussions with subject matter experts, for the tasks to be learned.) Silk screening methods were less expensive than using real instrument faces. The simulation of a malfunction was terminated at a point where important cues for action are provided; all the effects of inappropriate actions are not provided. (For example, cues for an engine fire are simulated without including progressive degradation of the system that results from failure to correct the emergency.) Flight dynamics limited to attitude control saved money and still were sufficient to provide training for flight conditions. In these cases, higher fidelity would not contribute to greater training effectiveness; or at least, the contribution was not considered sufficient to justify the higher costs.

As with any training system, learning not achieved in the low cost systems is accomplished with other media (e.g., classrooms, operational-flight trainers, aircraft, etc.) where the learning is more cost effective. A trainee, for example, adjusts rapidly to the real panels of the aircraft when trained with pictures of panels that are not directly involved in the procedures to be learned; especially where, e.g., operational flight trainer (OFT) sessions with more realistic panels are involved. It is more cost effective to achieve the small amounts of learning associated with realistic panels in the OFT or aircraft, because the realistic or real panels are required in the systems for other critical functions. The learning, therefore, is accomplished with no additional development costs; and because the learning is rapid, increases in utilization costs (of the OFT or aircraft) are small.

Decisions regarding the design of "training aids" (e.g., automated performance monitoring, student performance records, assisted problem set-up, etc.) were based largely on their expected contributions to the: (1) operation of the training system; (2) cueing of appropriate trainee responses; and (3) provision of useful performance feedback to trainees and instructors.

This, generally, is the rationale for designing the training fidelity, defining the task components to be trained with various media and providing instructional and operating aids for the two prototype systems. The approach appears to be valid in the current applications. Details of the current approach need to be better documented and its cost effectiveness needs continually to be increased.

Approximately 50 percent of the noted savings in development costs is attributable to these "fidelity" analyses. The remaining 50 percent savings is due to the use of equipment and documentation that satisfy but do not exceed the requirements for administering the training and supporting the system. Commercial (vice military) parts and standards were employed to obtain approximately equal savings for less costly materials and less complex documentation.

APPENDIX B

TECHNICAL INFORMATION REGARDING PERFORMANCE CURVES

As stated in Section II, all curves used in the analyses of transfer were logistic (S-shaped) functions. The general form of this equation is

$$Y = \frac{h}{1 + ge^{-kX}}$$

where $\underline{Y}$ = the predicted percent proficient trials,

$\underline{X}$ = the trial number,

$\underline{h}$ = the asymptote $\underline{A}$,

$\underline{k}$ = a rate constant,

$\underline{g}$ = $(\underline{A}-\underline{B})/\underline{B}$ where $\underline{B}$ is the beginning level, i.e., $\underline{Y}$ for $\underline{X}$ = 0, and

$\underline{e}$ = the well known mathematical constant.

All curves were fitted by the least squares method, that is, by minimizing the squared errors of prediction.

In fitting curves for each task, all trials were included so long as at least four of the six subjects had data for the trials. To increase stability of measures, mean performance for successive pairs of trials were the data used, except where radical irregularities occurred. The irregularities were due most often to a break of a day or more between trials. For example, for some tasks a subject may have had three trials the first day the task was attempted in the LCCPT. The fourth trial may have occurred one, two, or even three days later, and occasionally with some decrement. It was not feasible to account simultaneously for the sequence of trials and the sequence of days. Hence, if a substantial departure from monotonicity of data occurred, one that clearly exceeded sampling variation per se, data were combined across trials so as to reduce the lack of monotonicity. This adaptation was necessary for only two tasks.

It was not possible to fit meaningful curves to data for nine tasks. One of them had 100 percent proficiency for all trials, and five for all but the first trial. Such data do not yield unique solutions for any equational form, and especially when an exponential expression is involved. In such cases, the asymptote $\underline{A}$ was taken as 100 percent proficient trials, as was projected performance in the aircraft. The remaining three of these nine tasks did not receive enough practice to provide data needed for curve fitting.

Table B-1 shows the constants $\underline{A}$, $\underline{B}$, and $\underline{k}$ derived for the tasks by the least squares method, and the correlations $\underline{r}$ between actual LCCPT percent proficient trials and that predicted from the equations for the tasks. The last column of the table gives the mean total LCCPT trials for the six subjects, separately by task. In projecting aircraft performance, the first aircraft trial for a task was considered that task's LCCPT mean plus one, the second trial that mean plus two, etc. For example, for Normal Start, the X used in the logistic equation to project the first aircraft trial was $X = 9.5 + 1 = 10.5$; for the second trial, $X = 9.5 + 2 = 11.5$; etc. Projected performances were thus what would have been expected if trials had been continued in the LCCPT instead of the aircraft.

TABLE B-1. DATA RELATING TO CURVES FITTED TO LCCPT PERFORMANCE AND TO SUBSEQUENT AIRCRAFT PERFORMANCE

Task	r	A	B	k	Mean total LCCPT trials
Post-Takeoff Checklist	.992	106	53	.536	6.5
Normal Start	.976	109	40	.254	9.5
Blade Spread	.988	87	13	.342	8.0
Systems Check	.999	82	1	.874	7.7
No. 2 Engine Start	.983	95	20	.719	9.8
Rotor Engagement	1.000	83	3	.563	7.8
Rotor Disengagement	.994	95	8	.879	7.5
Blade Fold	.949	86	2	.999	6.8
No. 1 Engine Secure	.996	102	11	.372	7.0
Shutdown	.996	96	1	.084	7.5
For 15 tasks combined[a]	.995	90.8	12	.581	

Tasks for which performance was too high to fit curves

Taxi Checklist	Before Landing Checklist
Pre-Takeoff Checklist	After Landing Checklist
Takeoff Checklist	Postflight

[a]Tasks excluded were Postflight, System Check, Blade Fold, and Rotor Engagement; see Section II.

APPENDIX C

SUMMARY DATA ON DEVICE AND AIRCRAFT PERFORMANCE

Tables C-1, C-2, and C-3 present, respectively, summaries of (1) aircraft proficiency on tasks common to the LCCPT, 2C44, and aircraft; (2) device proficiency on tasks common to the LCCPT, 2C44, and aircraft; and (3) aircraft proficiency on tasks performed only in the aircraft. Each table shows, by task and by device group, weighted means of percents of proficient trials, comparable unweighted means, unweighted standard deviations (SDs), degrees of freedom (df) for t tests, and t ratios comparing device group means. The same data are also given for overall task means, and for general cockpit procedures (Table C-1) and general basic airwork (Table C-3).

The weighted means are the same as those shown in comparable tables (1, 2, and 3) in the text. The t tests were run on unweighted means, however, to avoid confounding correlated with independent observations.

As mentioned in the text, two differences are significant (p = .05) in Table C-1: The 2C44 group had higher percents of proficient aircraft trials on ASE Malfunction and Servo Malfunction. As shown in Table C-2, this group was also superior in device performance of ASE Malfunction ($p < .01$); however, as a group they had approximately twice as many device trials on this task (see Table 2 in text for record of device trials). On the other hand, the LCCPT group was superior in device proficiency on Before Landing Checklist ($p < .05$) and After Landing Checklist ($p < .01$), even though the differences in number of trials were small. There were no significant differences between the device groups on aircraft proficiency on tasks performed only in the aircraft.

TABLE C-1. SUMMARY DATA FOR PERCENT PROFICIENT AIRCRAFT TRIALS ON TASKS COMMON TO THE DEVICES AND AIRCRAFT

Task	Weighted Mean		Unweighted Mean		Unweighted SD		df	t
	2C44	LCCPT	2C44	LCCPT	2C44	LCCPT		
Normal Start	93	92	94	93	14.0	10.1	20	0.11
Blade Spread	94	92	96	83	12.9	37.3	18	1.10
Systems Check	76	66	76	63	13.9	26.7	20	1.37
No. 2 Engine Start	86	92	86	91	13.7	15.0	20	0.68
Rotor Engagement	71	62	72	62	18.2	21.9	20	0.99
Taxi Checklist	95	97	96	97	11.0	7.5	20	0.18
Pre-Takeoff Checklist	94	100	95	100	11.6	0.0	20	1.09
Takeoff Checklist	95	97	96	97	9.6	6.2	20	0.36
Post-Takeoff Checklist	96	97	96	97	9.9	6.2	20	0.33
ASE Malfunction	74	58	77	59	18.9	12.6	20	2.07*
Servo Malfunction	68	50	72	49	25.2	11.8	20	2.08*
Manual Throttle	79	75	76	78	26.8	17.8	20	0.15
Before Landing Checklist	94	94	95	95	11.1	10.6	20	0.02
After Landing Checklist	97	100	98	100	8.1	0.0	20	0.61
Shutdown	96	94	96	94	11.1	8.7	20	0.38
Rotor Disengagement	87	91	88	91	14.9	9.0	20	0.47
Blade Fold	67	73	65	80	36.9	22.4	14	0.84
No. 1 Engine Secure	88	95	86	96	31.8	9.3	16	0.69
Postflight	97	100	98	100	9.7	0.0	20	0.60
19-Task Mean	87	85	87	85	7.7	2.4	20	0.62
Cockpit Procedures	97	100	97	100	12.5	0.0	18	0.56

*p = .05

TABLE C-2. SUMMARY DATA FOR PERCENT PROFICIENT DEVICE TRIALS ON TASKS COMMON TO THE DEVICES AND AIRCRAFT

Task	Weighted Mean 2C44	Weighted Mean LCCPT	Unweighted Mean 2C44	Unweighted Mean LCCPT	Unweighted SD 2C44	Unweighted SD LCCPT	df	t
Normal Start	76	74	80	76	14.4	15.0	20	0.51
Blade Spread	84	77	85	79	11.0	19.0	20	0.77
Systems Check	57	63	58	63	15.1	12.5	20	0.66
No. 2 Engine Start	83	76	83	76	11.4	10.4	20	1.35
Rotor Engagement	67	66	69	67	20.2	8.8	20	0.22
Taxi Checklist	86	97	88	98	11.9	4.7	20	1.83
Pre-Takeoff Checklist	92	92	92	93	9.1	7.3	20	0.27
Takeoff Checklist	85	95	86	96	10.5	6.3	20	1.90
Post-Takeoff Checklist	88	89	89	91	10.5	10.5	20	0.27
ASE Malfunction	75	50	76	39	20.8	34.2	20	2.92**
Servo Malfunction	76	87	80	89	28.8	18.4	18	0.66
Manual Throttle	62	71	60	75	36.7	26.8	20	0.85
Before Landing Checklist	83	95	83	95	11.8	7.3	20	2.18*
After Landing Checklist	82	97	82	98	11.0	5.3	20	3.09**
Shutdown	82	76	80	76	18.3	11.4	20	0.53
Rotor Disengagement	80	71	79	71	16.1	14.0	20	1.08
Blade Fold	70	63	70	62	16.5	18.5	20	0.91
No. 1 Engine Secure	84	86	83	86	17.1	10.6	20	0.37
Postflight	92	100	86	100	29.8	0.0	18	1.07
19-Task Mean	79	80	79	80	8.5	5.7	20	0.36

*$p < .05$
**$p < .01$

TABLE C-3. SUMMARY DATA FOR PERCENT PROFICIENT AIRCRAFT TRIALS ON TASKS PERFORMED ONLY IN THE AIRCRAFT

Task	Weighted Mean 2C44	Weighted Mean LCCPT	Unweighted Mean 2C44	Unweighted Mean LCCPT	Unweighted SD 2C44	Unweighted SD LCCPT	df	t
Preflight	40	20	38	20	44.5	40.0	16	0.77
Course Rules	94	96	95	96	9.3	9.3	20	0.24
Taxi	90	97	92	97	11.8	7.5	20	0.90
Normal Takeoff	55	42	55	41	18.1	13.6	20	1.66
Running Takeoff	65	54	66	54	13.8	10.6	20	1.81
Beeper/Stick Trim/Bar Altitude	62	100	68	100	44.1	0.0	14	1.51
ASE Off Flight	61	66	66	65	27.5	17.6	20	0.12
ASE Off Landing	62	57	66	58	16.2	14.3	20	0.98
ASE Off Takeoff	50	35	56	38	33.9	41.0	18	0.98
Aux/Pri Off Flight	74	61	76	60	16.1	20.4	20	1.74
Auto Rotation	38	25	35	26	17.7	9.9	20	1.17
S/E Failure	35	23	33	27	34.3	34.0	18	0.30
S/E Malf Anal	29	33	21	38	27.5	45.1	16	0.92
S/E Approach Runway	50	44	52	44	23.8	17.5	20	0.14
S/E Land Runway	78	64	80	65	14.8	23.7	20	1.69
S/E Approach Pad	62	53	61	65	27.6	29.3	19	0.27
S/E Land Pad	65	76	66	77	25.5	23.6	19	0.86
S/E Waveoff	67	70	68	70	22.7	15.5	20	0.12
S/E Malf Abort Takeoff	69	48	68	53	27.1	22.9	20	1.12
Normal Approach	41	33	45	35	20.6	12.1	20	1.07
Normal Landing	62	53	62	52	12.2	17.5	20	1.50
Run On Landing	48	55	52	54	20.4	13.4	20	0.27
Pad Work	100	100	100	100	0.0	0.0	8	
Aux Off Landing	57	52	63	54	24.6	23.5	20	0.75
24-Task Mean	58	51	58	51	8.3	7.6	20	1.82
Basic Airwork	84	100	83	100	37.3	0.0	15	0.94

APPENDIX D

EXAMPLES OF AMPLIFIED SH-3H PROCEDURES CHECKLISTS

This appendix contains two examples of amplified SH-3H procedures checklists. Similar checklists for normal and emergency procedures were used during the demonstration of the use of the LCCPT in a program of instruction in which the role of the flight instructor was limited.

SH-3H LCCPT EXPANDED NORMAL AND EMERGENCY PROCEDURES CHECKLISTS

The SH-3H Low Cost Cockpit Procedures Trainer (LCCPT) is a training device designed to help you learn certain procedural skills necessary to the operation of the SH-3H helicopter. All procedures associated with operation of the SH-3H on the ground, e.g., Starting Engines and Engine Shutdown, as well as many inflight emergency procedures, may be practiced in the trainer.

The expanded SH-3H procedures training checklists are designed for use in the trainer and as a home study guide. Each item number of the procedures training checklist corresponds to the aircraft checklist item number found in the SH-3H NATOPS Flight Manual dated 1 November 1979. You will note that some items on the checklists have been expanded into component steps. Fleet Replacement Pilot actions entailed by each step must be memorized because these steps are not given in the checklists used in the aircraft.

Your instructor will explain the use of this expanded checklist in more detail. The "Systems Identification" column of the checklists describe the effect, if any, of the pilot action. The "Comments" column provides additional information. The "Pilot Performance Trials" columns (numbered 1 through 6) are for trainee use in keeping up with his own progress if he wishes, e.g., he may indicate in the appropriate column for future reference and study those items performed improperly.

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
1.	"Circuit breakers and switches"	1. "CHECK"							No systems responses will occur for this series of tasks since electrical power is not applied. Many of these checklist switches are displayed using photographs of the various panels in the LCCPT. The RP can learn their locations and control functions.	NATOPS does not specify a sequence order, but the RP should develop a consistent pattern to assure that all circuit breakers and switches are covered. See NATOPS FLIGHT MANUAL 3-14 to 3-16 for additional information on NORMAL START procedures.
	a. Pilots side console									
	(1) Compass control mode	(1) Set to SLAVE								
	(2) Latitude selector	(2) Set to current latitude								
	(3) Hemisphere selector	(3) Set to N or S as appropriate								
	(4) Meter selector	(4) Switch to ASE								
	(5) Vertical gyro switches	(5) Switch to PORT								
	(6) 4 hardover switches	(6) Check all OFF and covers down								
	(7) 4 channel disconnect switches	(7) Check all ON								
	(8) ICS AMPL SEL	(8) Set to NORM								
	(9) ICS MIC SEL	(9) Set to COLD								
	(10) Radio TRAN SEL	(10) Switch as desired								
	(11) ICS switch	(11) Set to ON								
	(12) Mixer switches	(12) Set as desired								
	b. Circuit breakers panels									b. The pilot and co-pilot visually check that the other's CBs are IN.
	(1) Pilots circuit breakers	(1) Check all IN								
	(2) Center circuit breakers	(2) Check all IN								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	(3) Copilots circuit breakers	(3) Check all IN								
	c. Overhead switch panels									
	(1) START MODE switch	(1) Set to NORMAL								
	(2) UHF ANT SEL	(2) Set to NORMAL								
	(3) CHAN MON switch	(3) Set to OFF								
	(4) BLADE FOLD MASTER switch	(4) Set to OFF, cover down								
	(5) BLADE FOLD SAFETY VALUE switch	(5) Set to OFF, cover down								
	(6) BLADES FOLD SPREAD switch	(6) Set to OFF								
	(7) WINDSHIELD ANTI-ICE switch	(7) Set to OFF								
	(8) CABIN HEATER FAN switch	(8) Set to OFF								
	(9) CABIN HEATER switch	(9) Set to OFF								
	(10) PITOT HEAT switch	(10) Set to OFF								
	(11) FWD ROT LT switch	(11) Set to OFF								
	(12) ROTOR HEAD LT switch	(12) Set to OFF								
	(13) STEADY-FLASH switch	(13) Set to STEADY								
	(14) MASTER SWITCH	(14) Set to OFF								
	(15) SIDE POS switch	(15) Set to OFF								
	(16) TAIL POS switch	(16) Set to OFF								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	(17) BEACON ANTI-COLL switch	(17) Set to OFF								
	(18) COPILOT FLIGHT INST LTS rheostat	(18) Turn to OFF								
	(19) CONSOLE & PANEL LIGHTS rheostat	(19) Turn to OFF								
	(20) INSTRUMENT EMER LTS rheostat	(20) Turn to OFF								
	(21) NON-FLIGHT INST LTS rheostat	(21) Turn to OFF								
	(22) PILOT FLIGHT INS LTS rheostat	(22) Turn to OFF								
	(23) HOIST switch	(23) Set to OFF								
	(24) BEEPER TRIM switch	(24) Set to OFF								
	(25) SONAR INTER INTERCOM switch	(25) Set to OFF								
	(26) TORQUE MOTOR switches	(26) Set both OFF								(26) Do not use this system.
	(27) ENGINE ANTI-ICE switches	(27) Set both OFF								
	(28) BATTERY SWITCH	(28) Set to OFF								
	(29) GENERATOR switches	(29) Set both OFF								
	(30) IGNITION switches	(30) Set both OFF								
	(31) NO 1 & NO 2 ENGINE T-Handles	(31) Push both IN								
	(32) R.F. STORES switch	(32) Set to OFF								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	(33) Accessory drive switch	(33) Set to ACCESS DR								
	(34) Both emergency throttles and speed selectors	(34) Set both CLOSE and SHUTOFF								
	(35) Emergency start switches	(35) Set both OFF								
	(36) Overspeed governor switches	(36) Set both OFF								
	(37) NO 1 & NO 2 engines' FIREWALL VALVES	(37) Set both CLOSE								
	(38) CROSSFEED switch	(38) Set to CLOSE								
	(39) 4 boost pump switches	(39) Set to OFF								
	d. Pilot's and copilot's instrument panels									
	(1) Radar altimeters	(1) Set both OFF								
	(2) UHF/DF switch	(2) Set to SHORT								
	e. Pilot's collective									
	(1) HOVER LT/FLOOD LT switch	(1) Center to OFF								
	(2) MASTER/RETRACK switch	(2) Center to OFF								
	(3) PRI/AUX OFF switch	(3) Center to BOTH ON								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	f. Center console									f. Copilot will normally perform these actions.
	(1) CONT IND PWR switch	(1) Set to OFF								
	(2) NAV PLTR mode switch	(2) Set to STBY								
	(3) NAV (doppler) mode switch	(3) Set to OFF								
	(4) CHAFF MASTER switch	(4) Set to OFF								
	(5) TACAN mode switch	(5) Set to OFF								
	(6) UHF mode switch	(6) Set as desired (usually PRESET)								
	(7) UHF function switch	(7) Set to OFF								
	(8) KY 28 power switch	(8) Set to OFF								
	(9) Cipher switch	(9) Set to P								
	(10) DROP TANK switches	(10) Set to OFF								
	(11) STORES LOAD control switches	(11) Set to OFF or SAFE								
	(12) DCU-77A switch	(12) Set to OFF								
	(13) UHF-2 function switch	(13) Set to OFF								
	(14) JETTISON ALL switch	(14) Set to OFF (cover down and shear wired								
	(15) JETTISON selector mode	(15) Set to SAFE								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	(16) HF mode switch and frequency	(16) Set to OFF and 29,000								
	(17) AUXILIARY FLOTATIONAL switch	(17) Set to OFF								
	(18) LF/ADF switch	(18) Set to OFF								
	(19) IFF MASTER switch	(19) Set to OFF								
	g. Copilot's side console	g. Copilot performs the following								g. The copilot will perform these actions while the pilot completes the same tasks on his side as described in 1(a) and (b) above.
	(1) ICS AMP SEL	(1) Set to NORM								
	(2) ICS MIC SEL	(2) Set to COLD or HOT								
	(3) Mixer switches	(3) Set as desired								
	(4) RAD TRANS SEL	(4) Set as desired								
	(5) RAD ICS switch	(5) Set to ON								
	h. Circuit breakers panels									
	(1) Copilot circuit breakers	(1) Check all IN								(1) Pilot can identify easier any copilot CBs that are out
	(2) Center and pilot circuit breakers panels	(2) Check all IN								(2) Copilot can visually check the pilot's CBs
2.	"Fuel dump switches"									SH-3H Groups A, B, and C FUEL DUMP switches are located on the instrument panel: SH-3H Group D and subsequent, the switches are located on the left side of the center console
	a. Forward switch	a. Switch OFF and shear wired								
	b. Aft switch	b. Switch OFF and shear wired								
		"OFF and SHEAR WIRED"								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
3.	"Brakes and tailwheel"									
	a. Parking brake	a. Depress brake pedal, pull parking brake handle OUT, then release brake pedal and handle							a. PARKING BRAKE ON advisory light goes ON (in the LCCPT this light is controlled automatically in the procedures mode or via the CPT PARAMETER page, e.g., type 106, OFF or ON, then press ENTER key at the IOS)	a. The parking brake system is not functional in LCCPT.
	b. Tailwheel lock handle	b. Pull tailwheel lock handle OUT "LOCKED"								b. The tailwheel lock system is not functional in LCCPT.
4.	"Battery switch"	Turn battery switch ON, verify that appropriate instrument and warning lights go ON "ON"							The following lights are on: Both MASTER CAUTION lights; advisory lights: PARKING BRAKE ON and CHECK BLADE-FOLD; Caution lights: #1 GENERATOR, #1 RECTIFIER, TAIL TAKEOFF, PRI SERVO PRESS, AUX SERVO PRESS, TRANS OIL PRES, #2 GENERATOR, #2 RECTIFIER, ROTOR BRAKE ON, and COMPASS FAIL	NOTE: COMPASS FAIL light goes OUT after warm up. Normally, the external power unit will already be plugged in on the flight line; therefore in the LCCPT during automatic procedures training, step 5 automatically occurs when battery is turned on to simulate this condition.
5.	"External power" (copilot type 101, ON and press ENTER key at IOS to connect power if in MANUAL TRAINING MODE)	Signal ground crewman to connect external power and verify that EXTERNAL POWER advisory light goes ON "CONNECTED"							EXT PWR ON advisory light goes ON, #1 and #2 RECTIFIER, and TAIL TAKEOFF caution lights go OFF	Connected automatically in procedures mode.
6.	"Battery switch"	Turn battery switch OFF "OFF"							No change, since external power is providing electrical power now	CAUTION: When using external power for an extended period, the battery switch should be OFF to prevent overcharging the battery.

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
7.	"Landing gear"	"CHECK"								
	a. Landing gear position indicator	a. Check wheels indicators-DOWN							a. Landing gear position indicators (symbolic tire tread) indicates gear DOWN)	Copilot normally performs these actions.
	b. Landing gear control lever	b. Check LDG GEAR CONT lever in down position-DOWN								
	c. Landing gear warning light	c. Press HDL LT TEST button-PRESS TO TEST; verify that light goes ON, then release							c. Warning light in wheel handle goes ON during press to test	
	d. Emergency landing gear extension handle	d. Check landing gear extension handle DOWN, FORE and AFT and shear wired								
	e. Emergency landing gear release lever	e. Check emergency landing gear release lever AFT and shear wired								
8.	"Drop tank switch panel" (SH-3H)	"CHECK" Verify switches OFF								This panel is installed on SH-3H Groups A, B, and C only - not on Group D.
9.	"Start mode switch"	Switch to NORMAL "AS REQUIRED"								Switches are placed in NORMAL position except for battery start so that the starter automatically drops out at 45% Ng.
10.	"Blade panel (radios SH-3D) hoist, trim"	"CHECK"								Since pilots may accomplish normal start procedures in either Blades Folded or Blades Spread position, they should be familiar with the control and switch positions for both conditions.

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	Blades Folded:	Blades Folded:							Blades Folded: These lights are ON when blades are folded:	
	a. Blades folded, control lock pins advanced, and safety valve open lights	a. Verify that these lights are ON and press to test the other lights							a. BLADES FOLDED, CONT LOCK PINS ADV, SAFETY VALVE OPEN and advisory panel CHECK BLADE FOLD	a. If these lights are not ON, then check that ACCESS DR is selected and red light is ON, then press to test the lights, then verify that Safety Valve, Master Fold Power are OFF and Blade Fold switch is centered.
	b. Hoist switch	b. Switch to CREW								
	c. Beeper trim switch	c. Switch ON							c. Beeper Trim not functional in *LCCPT*	
	Blades Spread:	Blades Spread:							Blades Spread: These lights are ON when blades are spread:	
	a. Blades Spread and Flight Position lights	a. Verify that these lights are ON and press to test the other lights							a. BLADES SPREAD and FLT POS	a. If these lights are not ON, then check that ACCESS DR is selected and light is on
	b. Hoist switch	b. Switch to CREW								
	c. Beeper trim switch	c. Switch ON								
11.	"<u>Torquemotor switches</u>"									
	a. Torquemotor power switch Eng. No. 1	a. Verify switch OFF								With the torquemotor switches OFF, the primary overspeed system remains operative
	b. Torquemotor power switch Eng. No. 2	b. Verify switch OFF								This system will not be used.
		"<u>OFF</u>"								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
12.	"Anti-ice switch"	Check OAT; switch to On if OAT is below 10° C and visible moisture is present "AS REQUIRED"							Outside air temperature indicates ambient temperature 22° C in LCCPT. This system is non-functional in the LCCPT.	
13.	"Ignition switches" a. No. 1 engine b. No. 2 engine	a. Switch to NORMAL b. Switch to NORMAL "NORMAL"								Engines will not start unless the ignition switches are in NORMAL
14.	"Accessory drive switch"	Verify switch is forward in ACCESS DR and red light is ON "FORWARD, LIGHT ON"							Accessory drive red light is ON	In Accessory Drive position, the No. 1 engine drives the accessory section without the rotor engaged, i.e., servos and transmission pressures and electrical power are available.
15.	"Manual throttles, speed selectors" a. No. 1 emergency throttle b. No. 2 emergency throttle c. No. 1 speed selector	a. Advance No. 1 emergency throttle full forward and aft b. Advance No. 2 emergency throttle full forward and aft c. Advance No. 1 speed selector from SHUTOFF to GROUND IDLE to full forward to GROUND IDLE and back to SHUTOFF position								c. & d. The pilot will have to pull down on the speed selectors' handles to get out of the GROUND IDLE DETENT positions

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	d. No. 2 speed selector	d. Advance No. 2 speed selector from SHUTOFF to GROUND IDLE to full forward to GROUND IDLE and back to SHUTOFF position "FREE AND OFF"								
16.	"Emergency start and override switches" a. Emergency start switch No. 1 engine b. Emergency start switch No. 2 engine c. Override switch No. 1 engine d. Override switch No. 2 engine	a. Verify switch OFF b. Verify switch OFF c. Verify switch OFF d. Verify switch OFF "OFF"								
17.	"Rotor brake"	a. Check that rotor brake is ON, hydraulic pressure indicator gage for minimum pressure 320 PSI and rotor brake caution light ON b. Recycle rotor brake handle, if necessary, to pump up pressure "CHECKED"							a. Pressure indicator indicates about 400 PSI (320 PSI min) and ROTOR BRAKE ON caution light is ON	b. Personnel should hold blades on both sides of helicopter to prevent head from shifting

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
18.	"Fire warning, caution, and advisory panels"	"CHECK"								
	a. FIRE TEST switch	a. Move springloaded switch to test (up) position, verify all FIRE WARNING lights come ON, and then release							a. No. 1 and No. 2 FIRE WARN lights on instrument panel and No. 1 and No. 2 ENGINE selector (Tee) handles (2 lights in each handle) lights go ON (total - 6 lights)	
	b. Caution panel and advisory panel lights	b. Depress LAMP TEST button on caution panel and hold, then verify that all caution and advisory panel lights illuminate, then release							b. All caution, advisory panel, and pilot/copilot master caution lights go ON while LAMP TEST button is pressed	b. Pressing either pilot's or copilot's master caution light resets it and allows subsequent unsafe conditions to reactivate the master caution light; the pilot normally resets it after identifying what caution light came on.
19.	"PMS disable switch" (SH-3H) Copilot pulls out red button on cyclic also	Pull out red button on cyclic "PULL"								If either button is depressed, no electrical overspeed protection is available. Do not use this system.
20.	"Fuel panel/quantity"	"CHECK"								Copilot performs these actions.
	a. Fuel firewall valve No. 1 engine	a. Switch to OPEN								
	b. Fuel firewall valve No. 2 engine	b. Verify switch CLOSED								
	c. Crossfeed switch	c. Verify switch CLOSED								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	d. Forward tank No. 1 and No. 2 pump switches	d. Verify switches OFF								
	e. Aft tank No. 1 and No. 2 pump switches	e. Verify switches OFF								
	f. Fuel quantity test gage switch	f. Press and hold fuel quantity test gage switch until fuel gages go to zero, then release							f. When depressing test switch, all fuel quantity gages drop to 0 within approximately 10 seconds and return to original position after test	f. This test shows that the fuel quantity indicating system is not sticking. NOTE: Some SH-3D/H helicopters have a center gage in place of the FUEL DUMP switches.
21.	"Battery switch"	Turn battery switch ON "ON"								CAUTION: Failure to have battery switch ON with No. 1 engine running may result in damage to the swashplate and rotary wing head, with inadvertent loss of external power
22.	"Lights"	Turn EXTERIOR LIGHTS MASTER SWITCH ON and place BEACON/ANTI-COLLISION switch to ANTI-COLLISION position "AS REQUIRED"								
23.	"No. 1 engine"	"START" Signal ground crewman ready to start No. 1 engine and receive an acknowledgement that crewman is ready								Pilot will brief copilot to clear left side, verify that fire guard is present, start clock on starter engagement and turn boost pumps ON at 19% Ng
	a. No. 1 speed selector	a. Hold No. 1 speed selector aft to SHUTOFF position								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	b. Starter button	b. Depress and release starter button and verify compass swings							b. Compass swings when starter engages, Ng accelerates to 19%. T_5 is below 100° C and positive oil pressure exists	b. Do not pull down on speed selector since this will disengage starter.
	c. FWD TANK No. 1 and No. 2 pump switches	c. Turn boost pump switches ON at 19% Ng							c. Boost pumps caution lights momentarily go ON (until pressure comes up) then go OFF	c. Copilot normally performs this action
	d. No. 1 speed selector	d. Advance speed selector forward to GROUND IDLE position, verify that compass swings at about 45% Ng. monitor and control T_5 acceleration							d. At about 45% Ng compass swings--indicating starter automatically disengaging--at GROUND IDLE Ng should be 56% +3%	d. If T_5 does not indicate liteoff within 10 seconds after advancing speed selector to GROUND IDLE, abort the start by pulling the speed selector down and returning to SHUTOFF position. Then turn boost pumps OFF.
	e. Engine start switch (on both cyclics)	e. Depress ENG ST switch to control T_5, acceleration and prevent it from advancing to 840° C							e. T_5 could advance quickly to about 800° C or higher unless the ENG ST switch is depressed quickly after initial "light off" due to the lag response	e. Pilot should anticipate fast rise in T_5 and depress ENG ST switch at the first indication of rapid increase. Normal starts are characterized by 700-750° C T_5 in 3 seconds. Abort start if T_5 reaches 840° C.
24.	"All gages"	"CHECK" verify that the ~~systems~~ are within the following ranges or values:								
	a. No. 1 engine Ng	a. 5[illegible] + 3%								
	b. No. 1 engine T_5	b. • 22° C Max is 540° C								
	c. No. 1 ENG OIL TEMP	c. Rising or in normal range (35° - 121° C)								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	d. No. 1 ENG OIL PRESS	d. Minimum 10 PSI and rising to normal range (25 - 60 PSI)								
	e. PRESS XMSN (MGB)	e. Above 12 PSI (normal range 45 - 90 PSI)								
	f. TEMP XMSN (MGB)	f. Rising or in normal range (40° - 120° C)								
	g. AUX HYD PRESS	g. Normal (range 1300 - 1600 PSI)								
	h. PRI HYD PRESS	h. Zero if blades folded or normal (1300 - 1600 PSI) with blades spread								
	i. UTL HYD PRESS	i. Normal (range 2600 - 3150 PSI)								
	j. Pilot's and copilot's No. 1 torque	j. Zero								
	k. Pilot's and copilot's No. 1 Nf/Nr	k. Nf about 50%/Nr zero								
25.	"Boost pumps" Forward tank No. 1 and No. 2 boost pumps	Switch to OFF "OFF"								The purpose of shutting off boost pumps is to check for possible air leaks in fuel lines. If fuel filters have been changed just prior to flight, the boost pumps should be left ON for about 1 minute to purge air from fuel line to prevent engine flameout.
26.	"Speed selector"	Pull down on No. 1 speed selector and advance slowly to obtain 104% Nf "104% Nf"							No. 1 engine Nf - 104%	No. 1 engine is driving the main transmission accessory section and 104% Nf provides correct phase voltage

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
26.	"Speed selector"	Pull down on No. 1 speed selector and advance slowly to obtain 104% Nf "104% Nf"							No. 1 engine Nf - 104%	No. 1 engine is driving the main transmission accessory section and 104% Nf provides correct phase voltage
27.	"Generators"									Normal operation of generator is indicated by caution panel lights OFF with both switches ON
	a. No. 1 generator switch	a. Switch to ON							a. No. 1 generator caution panel light goes OFF	
	b. No. 2 generator switch	b. Switch to ON, verify that both generators caution lights go OFF "ON"							b. No. 2 generator caution panel light goes OFF	
28.	"No. 1 overspeed system"	"CHECK"								
	a. Overspeed test switch *No. 1 engine*	a. Hold No. 1 overspeed *springloaded switch* ON (FORWARD) and verify Nf cycling							a. Nf should drop from 104% and cycle between 88% and 99%	
	b. Overspeed override switch No. 1 engine	b. Turn No. 1 overspeed override switch ON momentarily, verify Nf cycling stops, then turn OFF							b. Nf should return to 104% while the override switch is ON	b. The No. 1 overspeed test switch must be held in the ON position while the No. 1 overspeed override switch is turned ON
	c. Overspeed test switch No. 1	c. Release No. 1 overspeed springloaded test switch (goes to OFF) and verify that Nf returns to 104%							c. NF stabilizes at previous setting (i.e., 104%)	
29.	"External power" (Copilot type in 101, OFF and press ENTER key on IOS to disconnect power if in MANUAL TRAINING MODE; this is performed by the program when in Automatic Procedures Mode)	Signal ground crewman to disconnect external power, verify EXT PWR ON advisory light OFF and receive crewman's signal that unit is disconnected and clear "DISCONNECTED"							EXT PWR ON advisory light goes OFF	Advisory light on is operated by microswitch in external power receptable door and simply indicates that the door is open.

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
30.	"Compass system, console switches"								Most of these systems' switches are not functional in the LCCPT and are displayed using photographs where the pilot can learn controls, locations, and functions	
	a. Compass PUSH TO SYNC button	a. Depress switch and hold								
	b. Compass SYNC IND meter	b. Verify needle positions to null. ID 250, BDHI and STDBY compass should *align* $\pm$ *10°*								b. During shipboard operations, the compass system must be reset after becoming airborne and free to local magnetic disturbances.
	c. Control indicator switch	c. Select PWR if required								
	d. NAV doppler control elector	d. Select STBY								
	e. ASE engage button/light	e. Check ASE light OUT								e. If ASE light is ON, depress AUTOSTAB REL on either cycle
	f. TACAN	f. Set to REC and desired channel								
	g. UHF1 and 2	g. Turn both ON and set desired channels								
	h. HF	h. Verify OFF and set frequency at 29,000								
	i. LF (ADF)	i. Set to ON and desired frequency								
	j. IFF MASTER	j. Select STBY								
	k. IFF MODE switches	k. Set all ON								
	l. *RAD TEST - OUT - MON* switch	*l.* *Set as desired*								

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	m. MODE 3/A code selector	m. Select 1200								
	n. IDENT - OUT - MIC switch	n. Set to OUT								
		"AS REQUIRED"								
31.	"RAD ALT, BAR ALT, RAWS"									
	a. Radar altimeter push-to-test control	a. Turn push-to-test control knob clockwise to turn ON and set altitude indicator to 10 feet over land and 30 feet over water							a. Needle will cycle and drop behind no track area of RAD ALT gage initially until warmed up and then reads zero feet and the caution LOW light goes ON.	a. Turning either pilot or copilot RAD ALT knob ON activates the system (both gages) but both knobs must be turned counterclockwise to OFF position to turn system OFF
	b. Pilot's and copilot's barometric altimeters	b. Turn barometric set knob on BAR ALT to current barometric pressure and verify CODE OFF flag is not displayed.							b. Barometric pressure setting window indicates current setting (29.92 in LCCPT)	b. If either altimeter is more than $\pm$ 75 feet in error, then it is not acceptable for IFR flight.
	c. Radar altimeter warning signal indicator	c. Depress RAWS test button							c. Pulsating aural tones in both pilot's headsets (not in LCCPT) and ALTITUDE caution and both pilot's MASTER CAUTIONS lights flash ON and OFF	c. With the landing gear down, the RAWS will not provide an indication of an unreliable radar altimeter
		"SET AND TEST"								
32. (a)	"Servo sensor" (Blades Folded)	"CHECK"								
	a. Auxiliary servo switch on pilot's collective	a. Turn AUX OFF momentarily then center (both ON)							a. PRI SERVO PRESS caution light remains ON	a. If the blades are folded, the primary servo system will automatically be OFF (pressure zero and PRI servo caution light ON)

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	b. Auxiliary hydraulic pressure indicator	b. Verify HYD PRESS AUX remained normal (range 1300 - 1600 PSI) and AUX SERVO PRESS caution light does not go ON							b. HYD PRESS AUX remains at 1500 PSI and AUX SERVO PRESS caution remains OUT	b. If auxiliary servo pressure drops, the 1000 PSI primary sensor is malfunctioning. This is a very serious malfunction, if the primary servo should fail, the pilot could inadvertently turn off the auxiliary servo resulting in loss of flight control. The helicopter should not be flown.
32. (b)	"Servo sensor" (Blades Spread)	"CHECK"								
	a. Safety valve switch	a. Switch to OPEN position (UP) and verify correct lights							a. Safety Valve OPEN light goes ON, FLIGHT POS light goes OFF, and CHECK BLADE FOLD advisory light goes ON and BLADES SPREAD light remains ON.	
	b. Blade fold master switch	b. Switch to ON, verify correct light and primary servo indications							b. FOLD PWR ON and PYLON UNLOCKED lights go ON (Primary hydraulic pressure drops to zero and PRI SERVO PRESS caution light goes ON and both pilots' MASTER CAUTION go ON)	
	c. Auxiliary servo switch	c. Switch to AUX OFF, verify that HYD PRESS AUX remains normal and caution light does not go ON, then center switch								c. If auxiliary servo pressure gage reading drops, the primary (1000 PSI valve) is malfunctioning.

NORMAL START NO. 1 ENGINE (Procedure No. 2)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	d. Safety valve switch	d. Switch to CLOSED position and verify primary servo pressure indications							d. SAFETY VALVE OPEN PYLON UNLOCKED and FOLD PWR ON lights go OFF, primary servo pressure returns to 1500 PSI and PRI SERVO PRESS caution light goes OFF	
	e. Blade fold master switch	e. Switch to OFF, verify correct lights							e. FLIGHT POS light goes ON and CHECK BLADE FOLD advisory lights go OFF	

HOT START NO. 1 ENGINE (Procedure No. 16 or Manual Mode Code 123)

This malfunction occurs during the normal No. 1 engine start. The system failure indications will be apparent after completing Step 23, NORMAL STARTING procedures.

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
1-22.	(Copilot callout Steps 1-22 NORMAL STARTING PROCEDURES "COMMANDS"	Perform proper actions and make verbal "responses"								
23.	"No. 1 engine"	"START"								
		a. Hold Speed Selector AFT in SHUTOFF position								
		b. Depress starter button momentarily							b. Ng accelerates to 19%, engine oil pressure rises "off the peg," and T_5 decreases to below 100° C	
		c. Direct copilot to turn FWD TANK boost pumps switches ON @ 19% Ng								
		d. Advance Speed Selector to GROUND IDLE							d. Engine "lights off" and T_5 rapidly accelerates toward the over temp range	d. Pilot should always watch the T_5 and Ng gages closely during start. The typical hot start characteristics are a loud "light off" combustion sound with fast T_5 acceleration and the ENG START switch will not control the T_5 advance within limits
		e. Attempts to control T_5 with ENG START switch on cyclic							e. T_5 continues through 840° C	e. Depress ENG START switch way before the T_5 reaches 840° C because of the lag
		f. Recognize that a Hot Start is occurring, and abort start, and state the failure identification							f. T_5 continues above 900° C	f. DO NOT waste time describing this situation, since it happens so quickly; abort the start any time T_5 exceeds 840° C

HOT START NO. 1 ENGINE (Procedure No. 16 or Manual Mode Code 123)

No.	Checklist Items Description	Pilot Actions	Pilot Performance Trials 1	2	3	4	5	6	System Indications	Comments
	(Copilot comply as directed:)	g.* Secure the NO 1 engine:							g. T_5 at about 950° C and starts decreasing	g. T_5 may hang up and not decrease below 300° C
		*(1) Close Speed Selector to SHUTOFF								
	(2) Close firewall valve	(2) Close firewall valve								(2) & (3) Normally direct copilot to perform these actions
	(3) Turn off forward boost pumps	(3) Turn off forward boost pumps								
		h. Motor the engine if a Post Shutdown Engine Fire exists							h. T_5 decreases to below 300° C	h. Sometimes an internal engine fire will continue after a Hot Start abort and this procedure will cool the engine
		* (1) Speed Selector-SHUTOFF								
		* (2) Ignition switches-OFF								
		* (3) Battery switch-ON								
		* (4) Emergency start switch-ON								
		* (5) Engine TEE handle-PULL								
		* (6) Starter-ENGAGE								
		(7) If fire continues, have lineman discharge fire bottle in engine inlet.								
	i. ˉNo NATOPS PILOT'S CHECKLIST EMERGENCY PROCEDURES exist; see Flight Manual 3-15 & 3-16	i. Direct copilot to confirm that NATOPS EMERGENCY HOT START procedures have been completed								

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